the Petroleum Engineer

FOR MANAGEMENT

INTEGRATED EDITION OF THE PETROLEUM ENGINEER

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How Operations Research Works
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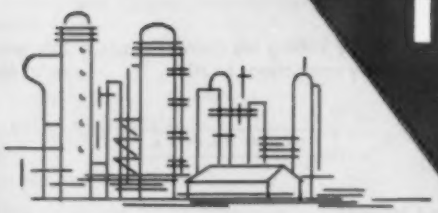

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Are You a Committeeman?

"If an American were condemned to confine his activities to his own affairs, he would be robbed of half of his existence."

So said the Frenchman De Toqueville more than a hundred years ago when he visited the young United States. That still holds today and probably in no part of the country is it more real than in our own petroleum industry.

We are organized from suppliers to marketers — from city to national areas. Last month a thousand oil women, members of Desk and Derrick Clubs, convened in Chicago. Next month some six thousand oil men will go there for the largest and one of the oldest industry organizations — the American Petroleum Institute.

If there is a man in the industry who does not belong to one or more organizations established to improve and forward operations and interests of the industry, truly he is being robbed of part of his existence. Because the policies, the standards, the ethics, all the operations of the industry are affected by the work and the "brain-storming" sessions of thousands of committees of associations.

We are constantly indebted to presidents and other officers of our organizations. They are our spokesmen — these no-dollar-a-year men whose service couldn't be bought but who spend invaluable time and, more often than not, their own money to help the industry. We have true industry statesmen among them. We can repay them only with appreciation and some understanding of the problems they try to solve.

Every working committeeman deserves our praise and our thanks. Their gains are ours. They may not always be right but they are in there pitching for our side and they should have our applause even if they strike out.

We attack our problems and smooth our sometimes rocky way by committees. It is much better than rule by fiat — this reign by thousands of committees. And remember, your influence is felt only as you share in the work.

If you haven't been on a committee or haven't held an organization office, there are two losers — you and your industry.

Ernestine Adams

Congrats and $25 to Mrs. JEWEL SUMMERSILL, Humble Oil & Refining Co., Baytown, Texas, for this quip.

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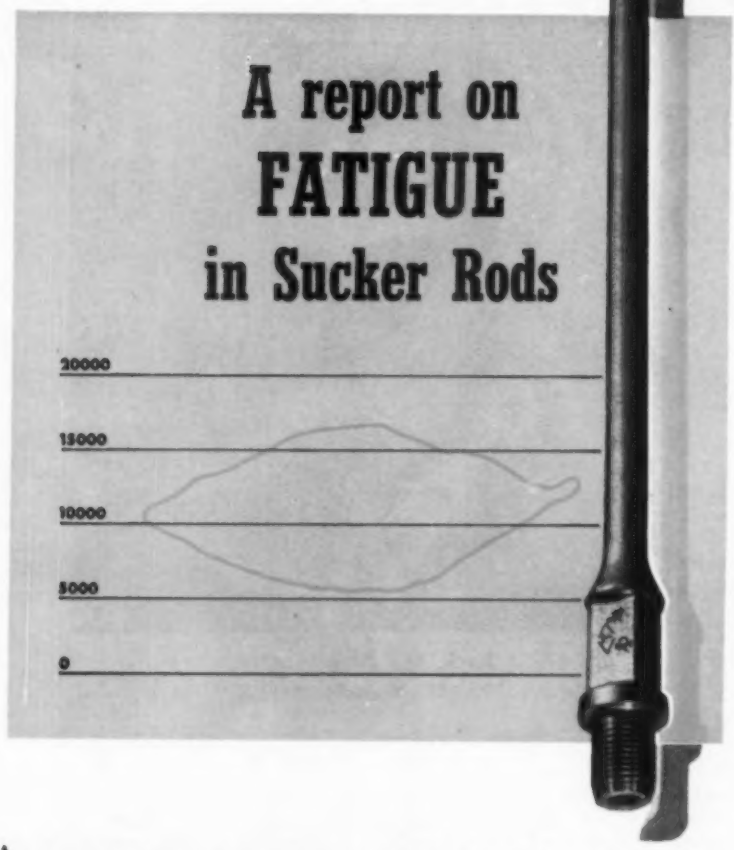
A report on FATIGUE in Sucker Rods



Although the degree of corrosion in any well environment is a primary factor causing fatigue, the purpose of this report is to identify, if possible, the cause of changes which occur to molecular structures when rod strings are subjected to excessive stress ranges, aside from corrosive action.

It is well known that any single stress that is less than the elastic limit can be applied to a string of sucker rods without establishing permanent stretch. However, lesser stresses repeatedly applied can cause breaks. The question is: Why?

When weighing a well with a dynamometer, *average* stresses are calculated—that is, the load divided by the cross-sectional area of the rods. Yet *service* stresses are actually higher at the rod skin, due to the physical factors, and since all breaks start at the rod surface, let's first consider *stresses at the surface.*

Stress #1 . . . is the surface stress at maximum tension from operational loads on the upstroke. Here we are lifting the rod string AND the oil.

Stress #2 . . . is the residual compression (a counteracting friendly stress) which can be built into quenched rods by *shot strengthening.* In reality, this is a booster which helps #3 as evaluated in the conclusions shown below.

Stress #3 . . . is the stress at the rod surface on the downstroke when the dynamometer reads lowest, and is frequently overlooked in considering well loadings as you will see in the following analysis.

The "net" stress severity on a sucker rod from the combination of the above three stresses is complex and is *not* calculable by simple addition and subtraction. Nevertheless, for illustrative purposes, we may grossly oversimplify to say . . .

- When rod ENDURANCE LIMIT is *greater* than #1 minus (#2 + #3), rods do not fatigue.
- When rod ENDURANCE LIMIT is *less* than #1 minus (#2 + #3), fatigue cracks will start.
- When fatigue cracks start, it is only a matter of time until rod failures will occur.

So ENDURANCE LIMIT becomes our concern. To make it as big as possible, "Oilwell" carefully liquid-quenches selected low carbon alloy steels . . . tempers to the hardness most favorable for rod endurance . . . and friendly stress #2 is added by our unique shot strengthening which compresses and hardens the surface as a bonus feature.

Of course you can delay fatigue action by (1) using subsurface pumps with the smallest bore that will get the desired production, (2) handling your rods with extreme care at all times so that bends or abrasions do not become the cause of surface cracks, and (3) standardizing on the size and grade rod that best meets your well condition.

All "Oilwell" rods are hot-straightened (to minimize residual stress associated with cold straightening), thoroughly degreased and coated with a baked phenolic plastic to protect surfaces from corrosion and abrasion before going into service, and carefully palletized on linseed oil-impregnated wood separators. Liquid quenching and shot blasting are provided on the rod grades which require these extra manufacturing steps to give you maximum performance.

The "Oilwell" Sucker Rod Comparison Chart gives detailed technical information on all leading brands of sucker rods. Send for one!

OIL WELL SUPPLY
DIVISION, UNITED STATES STEEL CORPORATION

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TRADE MARK

UNITED STATES STEEL

Petroleum Profile

Jack H. Abernathy
1956-57 President, AAODC

It may appear somewhat paradoxial that a calm, unassuming, youthful looking graduate engineer . . . whose way of life is deeply rooted in his Christian belief . . . should be head of an organization of drilling contractors, long characterized by their rough and tumble past. Perhaps the election of Jack H. Abernathy in October 1956, as president of the American Association of Oilwell Drilling Contractors was indicative of the evolution that has taken place in the drilling industry. By his forthright, sincere and enthusiastic efforts as their spokesman, he has helped bring stature and understanding to the AAODC.

And, he has spoken well . . . with the courage of his convictions that typifies his professional life. It was this same brand of courage . . . which he undoubtedly acquired from his father, a county judge . . . that accounted so heavily for his selection as vice president of the Big Chief Drilling Company . . . his present position. But, there were a lot of other qualities that earned him this job at a time when the seasoned drilling fraternity held little esteem for engineers. Jack was well equipped for the job.

He was born and raised in the booming oil town of Shawnee, Oklahoma, so it was only natural that he studied petroleum engineering at The University of Oklahoma . . . and was graduated in 1932 with honors. The depression was on and jobs were scarce, but his enthusiasm, scholastic record and willingness to do the dirtiest kind of work, brought him a job with Sunray Oil Corporation. In less than 10 years, he became the company's chief engineer at Tulsa, and in May 1941, he joined Superior Oil Company in a similar capacity.

When the Engineering Committee of the Oklahoma Wilcox Pool Engineering Association was formed, Jack became its chief engineer and chairman. With the courage of his convictions concerning the wettability of the Wilcox sand, he proposed a novel idea about the reservoir so convincingly that his program was adopted. History of the project proved him right.

When his engineering committee work was finished, he rejoined Sunray as general production superintendent. He became Big Chief's vice president in November 1945, and from that day until mid-1950, when Big Chief added a drilling engineer, Jack comprised the firm's engineering staff. At the beginning, the company operated five rigs, and at an early date, Jack demonstrated his drilling engineering ability. Footage rates at Elk City were about $9, and each well took from 67 to 70 days to drill. He felt this was too long, and began working out a drilling program that enabled Big Chief to drastically cut the time . . . and bring the footage rate to $6.75 per ft . . . and still come out with a profit.

Today Big Chief holds an enviable record in deep drilling with 11 rigs. . . most of them big ones. In his nearly 12 years at Big Chief, Jack has been a big factor in numerous advancements in drilling engineering, as well as progress in the business aspects.

His eagerness and willingness to take on responsibility earned him more non-paying jobs on industry organizations and committees than can be listed on a full typewritten page. In addition to his full-time job in guiding the progress of Big Chief, he has for the past 10 years been a board member of the AAODC. His participation in the Association's activities throughout this time include everything from committee work to chapter chairmanships to regional vice president.

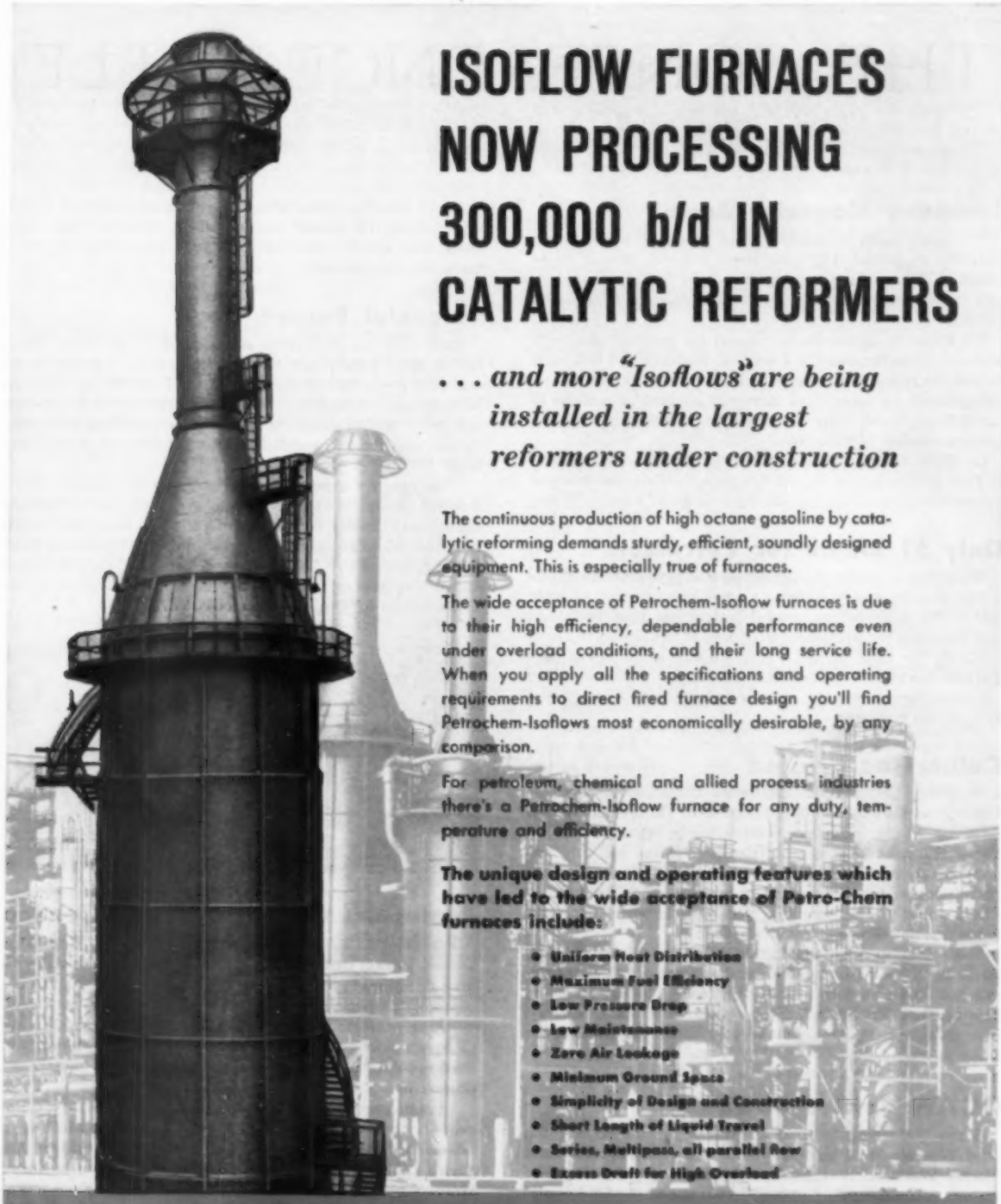
He has an unselfish devotion to the oil industry which he has served so well. Throughout his petroleum career, he has actively served as chairman of many important committees and study groups of the American Petroleum Institute . . . and today, is a member of the API Board of Directors. He has authored numerous significant papers ranging from reservoir engineering to drilling practices to industry economics . . . and is a recipient of the API Meritorious Service Award.

There are few industry organizations who have not enlisted his services. He's a member of the National Petroleum Council, the Mid-Continent Oil and Gas Association, the AIME, the Oklahoma Society of Professional Engineers. He has been an industry spokesman before many legislative bodies, both state and national. He will go to extremes to tell the industry's story . . . to high school students, at colleges.

Jack rarely misses Sunday services and is an Elder in the Westminster Presbyterian Church at Oklahoma City. He is also head of his Parish there.

Basically, Jack is a devoted family man, and spends every available moment with them. He goes to extremes to encourage his daughter in her interests in horses and dogs, while providing a guiding hand for his son who is taking an advanced degree in physics and teaching at Oklahoma University. You might say that his family is his number one hobby . . . and fishing might come next on the list.

You will go a long way to find anyone in the industry with so much faith and love for it. Although he relinquishes the helm of the AAODC in October this year, he will always be one of the industry's most respected spokesmen and top salesmen.



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. . . and more "Isoflows" are being installed in the largest reformers under construction

The continuous production of high octane gasoline by catalytic reforming demands sturdy, efficient, soundly designed equipment. This is especially true of furnaces.

The wide acceptance of Petrochem-Isoflow furnaces is due to their high efficiency, dependable performance even under overload conditions, and their long service life. When you apply all the specifications and operating requirements to direct fired furnace design you'll find Petrochem-Isoflows most economically desirable, by any comparison.

For petroleum, chemical and allied process industries there's a Petrochem-Isoflow furnace for any duty, temperature and efficiency.

The unique design and operating features which have led to the wide acceptance of Petro-Chem furnaces include:

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- **Short Length of Liquid Travel**
- **Series, Multipass, all parallel flow**
- **Excess Draft for High Overload**

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THE CONFERENCE TABLE

He who begins life by stifling his convictions is a fair way for ending it without any convictions to stifle. JOHN MORLEY

Company Magazine Boom

Not many parts of industry have grown so much as the company magazine. The petroleum industry uses it to an extensive degree. Larger companies have far-flung outposts, with staffs that want to keep up with company changes and policies.

We know of no survey on oil and gas publications more extensive than the one Dr. Dewitt C. Reddick has just completed. He reports on it on page E-3 of this issue. Company publications, he feels, have grown in content as well as in size. They not only have better variety but they cover more subjects frankly and effectively.

Dr. Reddick is Professor of Journalism at the University of Texas. This month he will have his third annual seminar for petroleum publication editorial staffs in Austin, Texas.

Only $1 Billion for Petroleum

When you consider the importance of petroleum products to this country it may come as a small shock to you to learn that of the multi-billion federal budget less than $1 billion was allocated for petroleum products. It amounted to about 1/72 of the total budget. Over $1 billion each was earmarked for electronic and communication equipment, for industrial raw materials, and for ammunition. Aircraft had $7.4 billion budgeted.

Culbertson Praised

Railroad Commission Chairman Olin Culbertson was honored at an appreciation banquet in Dallas last month given by all the industries coming under regulation of the Texas Railroad Commission. Leaders of the oil, gas, and transportation industries vied with each other in their praise of Culbertson, who has spent 16 years on the Commission. The banquet was an unofficial "Re-elect Culbertson" project as his present term expires this year.

Texas has been, indeed, fortunate in the personnel of its Railroad Commission, which regulates not only transportation but the petroleum industry in Texas. Culbertson, along with Lt. Gen. Ernest O. Thompson and William J. Murray, have given honest, intelligent service in their difficult job for many years.

OCAW Settles Down

Some 700 delegates met in August in Chicago for the third constitutional convention of the Oil Chemical and Atomic Workers International Union. Proposals to amend the union constitution numbered 163, but in the final analysis not a single word in the constitution was changed, reports the *Union News*.

There were also demands by union officials and some delegates that per capita payment to the union should be raised. Officers stated that the union would have to have more money to meet increasing costs of operation or would have to curtail the services it renders to local unions and members. All such proposals were defeated. Per capita dues remain $1.50 a month. *Union News* reports that the result of this means reduction in staff and in services. (Five OCAW international representatives have already been laid off.) It added cheerfully, however, that the result would be beneficial if it caused local unions to handle all their own work, and would raise the skill and competence of local members and officers.

Financial Report Good

Each year the petroleum department of the Chase Manhattan Bank publishes a financial analysis of the petroleum industry. From this we have taken the Free World statistics and reprinted them for convenient reference. We are always impressed by the comprehensive figures produced each year by this department, and find them a good source of information.

This year we were pleased to find that our January 1956 forecast of capital expenditures in *The Petroleum Engineer* tallies very closely to the 1956 figures released last month by Chase Manhattan. Our outlook predicted expenditures of $6.5 billion by U. S. oil companies here and abroad during 1956. The report by Frederick G. Coqueron gives about $6.55 billion for the same purpose.

Professors Invited to Study Conoco

President L. F. McCollum of Continental Oil Company, seated, second from left, is shown at Houston, Texas, with nine prominent professors invited to study and analyze the company's operations and policies. The unusual two-week "visiting professors seminar," in August, is designed to aid Conoco's management in identifying possible problems and weaknesses and to help the company achieve its long- range objectives.

Standing are Dr. Truman H. Kuhn, dean of faculty, Colorado School of Mines, Golden; Dr. Douglas McGregor, Massachusetts Institute of Technology, Cambridge; Dr. Charles C. Abbott, dean of the graduate school of business, University of Virginia, Charlottesville; Dr. G. Ernest Giesecke, vice president, Texas Technological College, Lubbock; Professor Paul Holden, Stanford University, Palo Alto, California; and Professor Ernest Dale, Cornell University, Ithaca, New York. Seated are Dr. Frank H. Sparks, chairman of the board and former president of Wabash College, Crawfordsville, Indiana; Mr. McCollum; Dr. Carey Croneis, provost, Rice Institute, Houston, Texas, and Dr. Paul H. Giddens, president, Hamline University, St. Paul, Minnesota. Absent when picture was taken was Professor W. Albert Noyes, University of Rochester, Rochester, New York.

Something to Look for

Engineers will enjoy the article "I Am a Kidnapper of Sorts," by a recruiter of graduating scientists and engineers in the September 14 issue of the *Saturday Evening Post*. It will give you a good idea of the rush for those bachelor degrees and the downright hunting for masters and PhDs.

Another national publication, *Look* magazine (October 1 issue), carries an article written by B. Brewster Jennings, chairman of the board of Socony Mobil. His article "How Can We Know Our Children Will Live Better?" foresees a poverty-stricken future unless we have enlightened public policies in respect to big business.

Engineering Salaries Continue Up

Starting salaries for engineers are still spiraling upward!

January and June engineering graduates at Illinois Institute of Technology commanded an average $473 per month salary, according to Earl C. Kubicek, director of alumni relations and placement.

"This is $82 more per month than the 1956 average for engineering graduates," Kubicek said.

"Salaries have increased every year since 1938, when we began keeping records," he explained. "At that time engineering graduates averaged $100 per month."

Electrical engineers again received the highest salaries — $515 a month, compared with $461 last year.

Other high department averages were: Metallurgical engineering, $490; industrial engineering, $484; mechanical engineering, $473; civil engineering, $470, and chemical engineering, $458.

You *Can* Argue With Success

In "How To Sell and Unsell Ideas," Fred DeArmond tells you how to convince a prospect or a customer, a jury, friend, a board of directors, a civic or business group — any audience of one, 10 or 100 persons. (Published by Lloyd R. Wolfe, 476 Park Avenue, Glencoe, Illinois. 237 Pages. Price, $7.50.)

He is not concerned with the *matter* but with the manner of conducting a controversy — what to say, how to say it, and how to make your points stick.

It is only the hermit or the zero-personality that never has to argue. The man or woman that must frequently attempt to convert an audience to his way of thinking, will find in "How To Sell and Unsell Ideas" all the pros and cons, the do's and don'ts, the answers to "why didn't I think of that at the time?"

The Perforated Spirit

The fellows up in personnel,
They have a set of cards on me.
The sprinkled perforations tell
My individuality.
And what am I, I am a chart
Upon the files of IBM
The secret places of the heart
Have little secrecy to them.
It matters not how I may prate,
They punch with punishments the scroll.
The files are masters of my fate.
They are the captains of my soul.
Monday my brain began to buzz;
I was in agony all night.
I found out what the trouble was:
They had my paper clip too tight.

—*Morris Bishop.*

Find Words of One Syllable

One important organization on the national scene is the Committee for Economic Development. It is non-profit and non-political. Its purpose is to help our nation and our economy to a better understanding of what makes us grow. We suggest that if CED would write its reports in words of one syllable it would get about 10 times as much attention.

For instance, recently in a federal tax reform report the committee stated that keeping federal expenditures from "rising at a rate that absorbs all available tax revenues generated by economic growth is perhaps the most important domestic issue facing the nation today."

We translate that to mean "your taxes rise as fast as your earnings so you can't get ahead." Or maybe we don't understand those big words either.

No Profits — No Union

Socony-Mobil was accused by a vice president of the Oil Chemical and Atomic Union of using its increased productivity and profits to club the workers and to raid the union contract instead of "sharing with the employees in a small way these increased profits."

This was reported by *Union News* in connection with a strike at the company's East St. Louis refinery. It seems the company made a profit last year and so it can afford to close down the plant.

The other side of the picture was not presented. If the company had not made a profit the plant would eventually have been closed down anyway. There would have been no jobs and, of course, no union to strike a profit-making company.

How You Opsearch

Did you read in the August issue of *The Petroleum Engineer* "Why Should Management Be Interested in Operations Research?" by Gilbert C. Jacobus? It was a clear review of a new method recently used efficiently by management. On page E-11 Mr. Jacobus gives a brief and stimulating report on "How Operations Research Works."

"Opsearch" is another aid to decision-making.

Welcome Booklet

When you visit Wagner Electric Corporation in St. Louis, Missouri, you're handed a booklet with the title "Welcome to Wagner Electric Corporation, 6400 Plymouth Avenue, St. Louis 14, Missouri... Electrical and Automotive Products." The booklet goes on in a friendly and informative way telling you where you can park the car, what the office hours are, where you can smoke, etc.

Then it gives a brief history of Wagner Electric, a diagram of the plant and buildings, the office departments, the factory departments, the automotive products, the electrical products, and last the branch offices and addresses.

This is a courteous and helpful gesture. It is given to all those who visit the offices and when they make a second call they are well informed about the company.

HIGHLIGHTS

★ ★ ★

Digest of News and Comment

Natural gas — "the most sought after fuel" — is in even greater demand today, reports officials of Texas Railroad Commission. There is definitely a producer's market developing and gas well completions are rising. One RR Commission engineer says "We have one or more calls from prospective gas buyers looking for reserves almost weekly." Wellhead prices are rising, too, with going price now about 13 cents per Mcf, although the state average price is about 8.5 cents, because of old, existing contracts.

★ ★ ★

Tanker building program and new refinery project of Esso Petroleum Company, Ltd., British subsidiary of Jersey Standard, has called for new financing by the company for the equivalent of $19,600,000 of 6 percent first debenture stock. Subscriptions for the new stock offering are expected to be complete by March 1958. The refinery, which will cost $50 million, is to have an annual capacity of 4,500,000 tons of oil. The debentures will also help finance Esso's 18 supertankers.

★ ★ ★

American oil company invest-ments have shown marked rise in earnings in 1956, the Commerce Department reports. This income, which led return on all U. S. foreign investments, increased $200,000,000 to $1.4 billion for the year. Earnings were about the same in 1955 in Middle East countries, but increased substantially in Venezuela, Canada, and Western Europe.

★ ★ ★

Oil and gas producer groups in five states are supporting a test case before the U. S. Tenth Circuit Court of Appeals in Denver to see if the U. S. Supreme Court actually meant to give governmental control over the "real" independent gas producer in the 1954 Phillips case. The case involves Saturn Oil & Gas Company versus FPC, and according to TIPRO, is the first such case involving an unintegrated firm.

★ ★ ★

Mexican oil development through use of foreign capital, appearing near in recent months, is meeting with fresh opposition. Financing has been scheduled from several French banks, but additional out-of-Mexico aid may be dropped because of a feud between a banker and the powerful Mexican oil workers union. Alfonso Diaz Garza, who advocates outside aid, claimed the industry had gone backward since the 1921 expropriation. The workers' syndicate differed with the banker . . . declared it would fight any new foreign investment in the Mexican oil monopoly.

★ ★ ★

A medical department has been established by The Ohio Oil Company. Dr. John H. Hege heads the department — part of the personnel division. It will counsel employees in health problems, give medical guidance in workmen's compensation, physical exams, disability retirements and employee safety; conduct liaison between physicians and the company, and provide technical guidance to company nurses at various Ohio Oil offices.

★ ★ ★

Crude oil price structure is being studied by a federal grand jury in Alexandria, Virginia, as a continuation of investigations of petroleum pricing. Acting for the Justice Department, the group has subpoenaed API for its agenda and minutes at committee meetings in 1953 and from January 1, 1956 to the present. Documents are being called for from files of IPAA, Texas Oil Jobbers Association, National Oil Jobbers Association, and others.

★ ★ ★

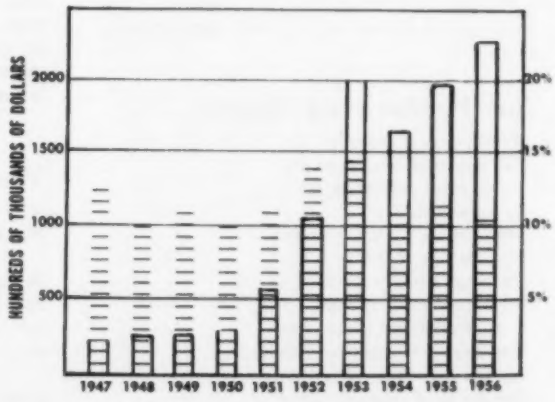
"Ratable take" controversy has flared in Louisiana and involves properties of William G. Helis, chairman of State Mineral Board. An order to buy oil from all wells in University field near Baton Rouge was questioned at a Department of Conservation hearing. T. G. Markley complained oil from his five wells was not being bought; Conservation Department ordered Sun Oil Company to buy the oil. Sun is also carrier. Basic issue involves legality of the order to require purchase of the crude as well as transport it, which is required of pipelines as "common carriers." Because of the conflict Sun has given notice that it will stop purchase of oil from the Helis-owned wells in December.

★ ★ ★

Oil's centennial celebration plans are beginning to crystallize. American Petroleum Institute, steering the year-long observance, has named W. R. Huber as director. Huber, Gulf Oil director of public relations, has been given a company leave of absence and is moving his offices to API headquarters in New York. Committees have been working for more than a year on the Centennial. The one-hundredth anniversary commemorates Drake's discovery of oil at Titusville, Pennsylvania, August 1859.

★ ★ ★

Two Texas Company scientists are to be given top American Chemical Society awards — the first time in the history of the organization that two have gone to men in the same research group. Texaco's DuBois Eastman, director of the Montebello, California, laboratories, receives the industrial and engineering chemistry award, and Robert P. Eischens, in the physical research department of the Texaco Research Center, Beacon, New York, receives the precision scientific company award in petroleum chemistry.



RESEARCH, ENGINEERING AND DEVELOPMENT EXPENDITURES

▭ *Dollars* ≡ *Percent of Sales*

Dollars and percent of sales devoted to research by petroleum suppliers is illustrated by this graph from Consolidated Electrodynamics Corporation's annual report. One out of every $10 sales went to research and development in 1956. Estimates for research spending by Petroleum Equipment Suppliers Association members run over $100 million.

SCRUBOSPHERE* ...

... FOR *Cleaner Gas* AT *Less Cost!*

*PEERLESS SPHERICAL
DUST and LIQUID SCRUBBER
FOR GAS PIPELINES

(A) The majority of incoming liquid and solid particles are directed down into reservoir. 1

(B) Lighter solid particles carried by gas stream are separated on surfaces of contactor which are kept wet and clean by revolving thru liquid reservoir. 2

(C) Contactor is revolved by explosion-proof gear motor.

(D) Mist Extractor removes any remaining liquid particles from gas stream prior to outlet. 3

- The **dust removal ability** of the SCRUBOSPHERE **is superior** because it utilizes **wetted surfaces** for dust collection which are much more closely spaced than in conventional equipment.
- **Oil loss is minimized** because the oil used to wet the dust collecting surface is lifted mechanically instead of bubbling gas through the oil which results in foaming and loss due to creation of hard-to-separate fine particles.
- **Maximum performance and low cost** — The spherical design means high capacity and performance because it provides maximum dimensions for the contactor and mist extractor which normally are limiting factors in scrubber designs. The vessel cost is reduced because required vessel thickness is only one half that required for cylindrical vessel of same diameter.
- **Versatility** — separates solid and liquid particles with equal efficiency.
- **Low pressure drop** — ½ to ¾ psi at rated capacity depending on nozzle size.

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Write for test data showing dust removal and oil loss of Peerless Scrubosphere as against conventional dust scrubber.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Voluntary reduction in oil imports has done little to ease cuts in domestic production. Actual imports, although below plans, are higher than last year. State conservation boards have not been able to up allowables and some are reduced. One reason — demand has hit a snag. Change from 1956 is invisible to naked eye.

★ ★ ★

Iranian oil output sets record in July. Production figures of 756,000 bbl per day established an all-time monthly record for Iranian oil fields. Six-months total of 6.9 million tons exceeds any previous six-months period.

★ ★ ★

Demand in August for petroleum products was only slightly more than that in 1956. Chase Manhattan Bank monthly review stated that it was only 1.1 percent above the year before. On the other hand supply of new oil continued excessive so that inventory of refined products and crude is now too heavy, the review said.

★ ★ ★

Certain congressmen are aiming at government ownership of natural resources, in the opinion of Felix Chappellet, Western Oil and Gas Association vice president. In a speech Chappellet asserted that Natural Gas Act amendment, recognizing that production of natural gas is not a monopoly, was defeated because "big-city congressmen have set their course toward government ownership . . . have misled their constituents into believing their action was to keep profits down."

Coming next month —

the first of a new and exciting series of

Special Issues on

FOREIGN "AREAS OF PROMISE"

In the November Special Issue we present

VENEZUELA

No. 1 Foreign "Area of Promise"

. . . because of its great potential
. . . because of its equitable oil law
. . . because of its people and government
. . . because of its Western Hemisphere location

Our Management Editor, Ernestine Adams, has just returned from an extended field trip where she met government officials, concession owners' top technical and management men . . . and contractors in "Areas of Promise" outside the United States.

The first reports will be published in our November issue. This Special Issue will have the most comprehensive collection of technical and management articles ever assembled on oil and gas operations in Venezuela.

Many readers will recall Special Issues on "Areas of Promise" we published a few years ago. They were immensely popular, so our Reader Service Department is printing extra copies of the new "Areas of Promise" issues. You won't want to miss this informative series. If you are not receiving a personal copy of "The Engineer," send your subscription now to —

READER SERVICE DEPARTMENT
The Petroleum Engineer Publishing Company
P. O. Box 1589, Dallas 21, Texas

Two well-known leaders in petroleum industry were selected by Texas Mid-Continent Oil and Gas Association for its Distinguished Service Award. Robert F. Windfohr, independent, Fort Worth, and James C. Donnell II, president, Ohio Oil, were recognized for outstanding contributions.

★ ★ ★

Net income decreased for natural gas pipeline companies reporting to Federal Power Commission. They had net income of $234,723,339 during the year ended July 31, a loss of 1.3 percent under the preceding 12 months. For the same period operating revenues of $2,252,116,183 meant an increase of 11 percent.

★ ★ ★

National Planning Association wants prompt government financial aid to construct a number of atom-fueled electrical power plants. NPA report said the United States must have something to offer if it is to achieve world atomic leadership. Outlook for profits is too remote to justify relying exclusively on private investment.

★ ★ ★

Following Rumania, Germany is now Europe's largest oil producer, thanks to 11 percent increase in its 1956 production. This figure was 2.6 percent higher than the average increase recorded for world production. during the same period.

★ ★ ★

A new and possibly powerful source of chemical energy called "fragments of normal chemical molecules" was discussed in Washington by scientists of four nations. In recent years methods have been developed for capturing and storing "free radicals." Knowledge of energy sources keep well ahead of our needs.

★ ★ ★

Another offshore area looms. Pennsylvania received two bids for rights to explore for oil and gas off shore of Lake Erie. Higher bids of $3.79 and $1.11 an acre for two tracts were made by New York State Natural Gas Corporation. Kewanee Oil Company made bids of 33 and 43 cents.

★ ★ ★

Securities and Exchange Commission ordered Cities Service to alter its relationship with Arkansas Fuel Oil Corporation, a 51.5 percent controlled subsidiary. Last year the commission refused to relieve Cities Service from regulation as a public utility holding company until it changed relationship with Arkansas Fuel.

Good Wells Make Good News

October, 1957

DOWELL FRACTURING SERVICES are designed to give you good results and quick return on investment. They are offered in all volumes and injection rates, with a wide variety of fracturing fluids and addition agents. Here are some recent outstanding examples of the results obtained from Dowell fracturing services.

- **Ward County, West Texas** (Old Well): Gyp deposits had reduced production from well in waterflood project (Yates formation) to 20 bopd. Monthly workovers in this field, to remove gyp from pumps, were not uncommon. This was increasing production costs. Dowell recommended Sandfrac®, using 5000 gallons lease crude with 10,000 pounds sand and 600 pounds Gypban* to prevent the formation of gyp deposits. Injection down casing averaged 32.8 bpm. *Four months after treatment, production had stabilized at 115 bopd—without requiring a single workover. Treatment cost of $2,717 was recovered during first two weeks after treatment.*

- **Crawford County, Illinois** (New Well): Completion was made by perforating between 1450 and 1518 feet in two zones of the Benoist and one zone of the Aux Vases. Dowell recommended Petrojel* using 9000 gallons thickened crude and 13,500 pounds sand. Treatment was in three, 3000 gallon stages. 52 Buna-N—covered nylon balls were injected during stages to plug, temporarily, zones already fractured. From a show of oil before treatment, well swabbed 10 boph following Petrojel service and was put on pump at 140 bopd. *Treatment costs of $1,343.45 paid out in less than 14 days.*

- **McPherson County, Kansas** (Old Well): Production from perforations in Maquoketa dolomite (3326 to 3356 feet) had declined to 10 bopd. Dowell fractured with Stratafrac®, using 3000 gallons acid-kerosene emulsion and 3250 pounds sand. Injection was down tubing. *Immediately following treatment, the well tested 60 bopd. 330 days after treatment, well was still producing 35 bopd. Total cost of Stratafrac service paid out in less than 60 days.*

- **Major County, Oklahoma** (Old Well): Production from Manning formation through perforations, 6745 to 6835 feet, had decreased to 5 bopd. Operator ordered Riverfrac*, using 150,000 gallons fresh water with 12,000 gallons Dowell "X" Acid and 100,000 pounds sand. Treatment was down 5½-inch casing at 45 bpm average. *After 60 days, well had stabilized at 38 bopd.*

For quick payout and good ultimate recovery, start with the right treatment. Let your Dowell engineer tailor your fracturing treatments to the requirements of your wells. For service call any of the 165 Dowell offices in the United States and Canada; in Venezuela, contact United Oilwell Service. Or write Dowell Incorporated, Tulsa 1, Oklahoma.

Services for the oil industry

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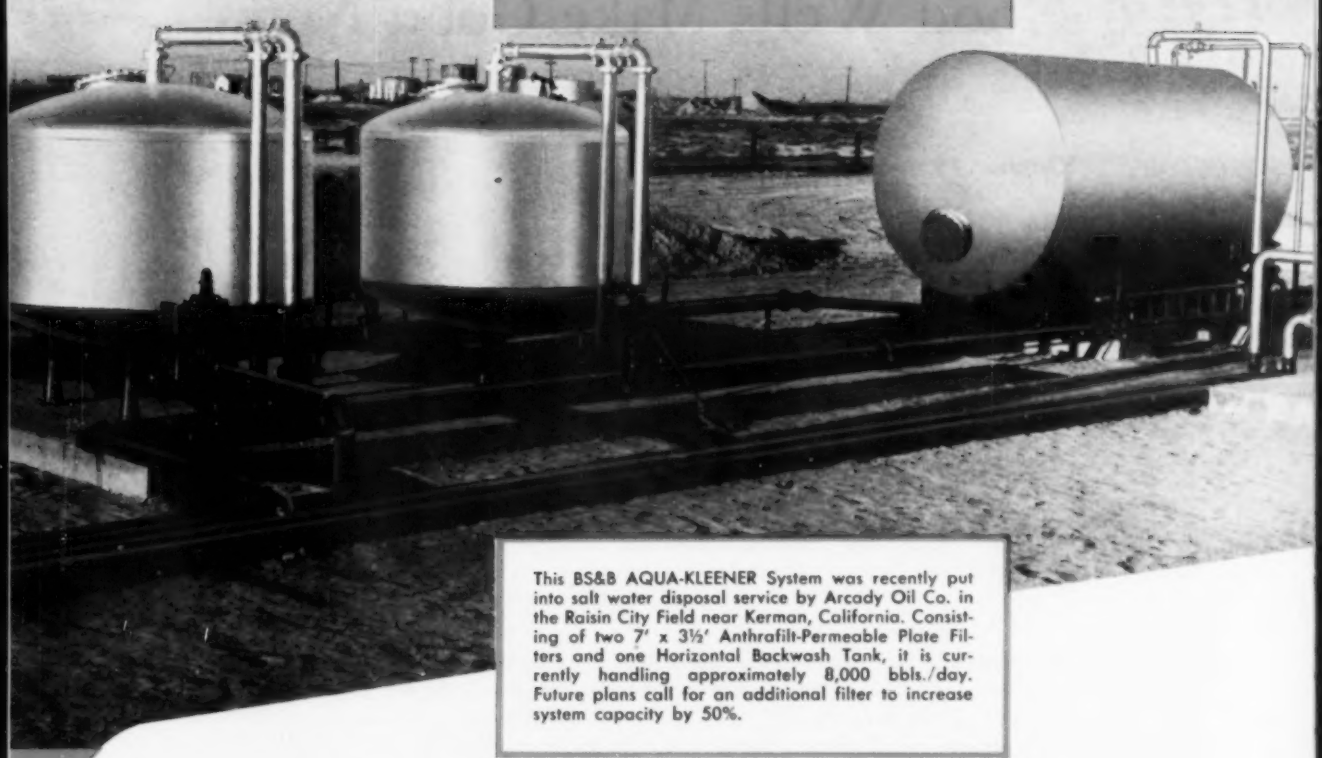
Where Water Disposal Is A Problem . . .



This BS&B AQUA-KLEENER System was recently put into salt water disposal service by Arcady Oil Co. in the Raisin City Field near Kerman, California. Consisting of two 7' x 3½' Anthrafilt-Permeable Plate Filters and one Horizontal Backwash Tank, it is currently handling approximately 8,000 bbls./day. Future plans call for an additional filter to increase system capacity by 50%.

Install a BS&B AQUA-Kleener® System!

Today, more and more oilfield production men are turning to the BS&B AQUA-KLEENER System as a practical and economical solution to the problem of lease-produced water disposal without the contamination of land areas or surface waters, and without clogging of water injection wells.

Through an improved process of settling and filtering, AQUA-KLEENER removes oil traces and solid particles, and prevents air from contacting the water—thereby reducing precipitation due to oxidation of iron, minimizing corrosion, holding carbon dioxide in solution, retarding aerobic bacteria growth, and in most cases, eliminating the need for chemical treatment of the water.

Each of the components of the AQUA-KLEENER System can be utilized separately or in various combinations, as determined by the type of application and degree of water conditioning required.

If you have a water injection or disposal problem, it will pay you to get full details on BS&B AQUA-KLEENER — today's outstanding water conditioning and filtering system! Ask your BS&B Man — or write to . . .

EFFICIENCY OVER 60 YEARS BS&B RELIABILITY ANOTHER EXAMPLE OF PRODUCT LEADERSHIP

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Oilfield Equipment Division, Dept. 1-C10

P. O. Box 1714

Oklahoma City, Oklahoma

Meetings

Oct. 1-2—**Texas Mid-Continent Oil & Gas Association,** 38th annual meeting, Texas Hotel, Fort Worth, Texas.

Oct. 1-2—**API Executive Committee of Board of Directors,** Greenbrier Hotel, White Sulphur Springs, West Virginia.

Oct. 1-4—**National Association of Corrosion Engineers,** South Central region, Oklahoma City, Oklahoma.

Oct. 2-4—**National Association of Corrosion Engineers,** Southeast region meeting, Sherman Hotel, Chicago, Illinois.

Oct. 6-9—**The Society of Petroleum Engineers, AIME,** annual fall meeting, Adolphus, Baker and Statler Hilton hotels, Dallas, Texas.

Oct. 6-10—**ASTM Committee D-2 meeting,** Sheraton-Park Hotel, Washington.

Oct. 7-9—**ASME, ASLE-ASME Lubrication Conference,** Royal York Hotel, Toronto, Ontario, Canada.

Oct. 7-9—**American Gas Association,** annual convention, Kiel Auditorium, St. Louis, Missouri.

Oct. 7-9—**National Electronics Conference,** 13th annual, co-sponsored by Illinois Institute of Technology and two other universities and two technical societies, Hotel Sherman, Chicago, Illinois.

Oct. 7-11—**American Institute of Electrical Engineers,** 1957 fall general meeting, Morrison Hotel, Chicago, Illinois.

Oct. 10-11—**California Natural Gasoline Association,** 32nd annual fall meeting, Huntington-Sheraton Hotel, Pasadena, California.

Oct. 10-11—**National Association of Corrosion Engineers,** Southeast region meeting, Dinkler-Tutwiler Hotel, Birmingham, Alabama.

Oct. 10-12—**ASME, Fuels-AIME conference,** Chateau Frontenac, Quebec City, Quebec, Canada.

Oct. 10-13 —**Louisiana Gulf Coast Oil Exposition,** Lafayette, Louisiana.

Oct. 13-15—**American Association of Oil-well Drilling Contractors,** 17th annual meeting, Mayo Hotel, Tulsa, Oklahoma.

Oct. 13-16—**American Petroleum Credit Association,** 33rd annual conference, Mark Hopkins Hotel, San Francisco, California.

Oct. 13-19—**OIL PROGRESS WEEK.**

Oct. 15-16—**Gas Measurement Institute,** 5th annual, American Legion Hall, Liberal, Kansas.

Oct. 16-17—**South Dakota Independent Oil Men's Association convention,** Alonzo Ward Hotel, Aberdeen, South Dakota.

Oct. 16-17—**The Society of Petroleum Engineers, AIME,** Southern California Petroleum Section, fall meeting, Biltmore Hotel, Los Angeles, California.

Oct. 17-19—**National Society of Professional Engineers,** fall meeting, Grand Pacific Hotel, Bismarck, North Dakota.

Oct. 18—**American Institute of Chemical Engineers,** 12th annual technical meeting of the South Texas section, Moody Convention Center, Galveston, Texas.

Oct. 20-22—**National Association of Oil Equipment Jobbers,** annual convention and trade show, Hotel Peabody, Memphis, Tennessee.

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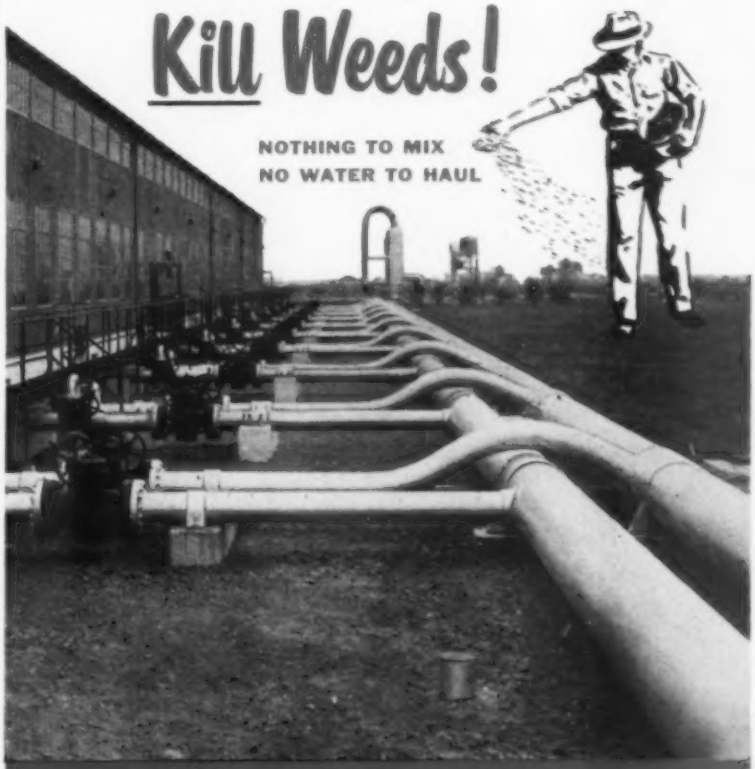
Kill Weeds!



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This weed killer gives lasting control of fire-hazardous vegetation... and that's what you need in the Petroleum Industry. Low cost, easy application, safety and convenient packaging are other important features you get with Concentrated BORASCU. Use it anywhere, in any climate, to destroy weeds. Concentrated BORASCU is nonpoisonous, nonflammable, and noncorrosive to ferrous metals... try it!

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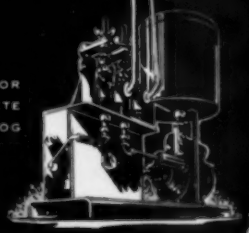

WRITE FOR COMPLETE CATALOG

Manzel

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A Division of Houdaille Industries, Inc.

Oct. 20-23—**Empire State Petroleum Association,** fall meeting, Lake Placid Club, Lake Placid, New York.

Oct. 21-23—**American Society of Mechanical Engineers,** conference on development in the field of power, Americus Hotel, Allentown, Pennsylvania.

Oct. 23-24—**Computer Applications Symposium,** sponsored by Armour Research Foundation, Hotel Sherman, Chicago, Illinois.

Oct. 23-25—**National Association of Corrosion Engineers,** Western region meeting, U. S. Grant Hotel, San Diego, California.

Oct. 24-25—**National Association of Corrosion Engineers,** Permian Basin Corrosion Tour, Lincoln Hotel, Odessa, Texas.

Oct. 24-25—**Western Petroleum Refiners Association,** regional technical-industrial relations meeting, Rufus Garrett Hotel, El Dorado, Arkansas.

Oct. 25—**Natural Gasoline Association of America,** southern regional, Washington-Youree and Captain Shreve hotels, Shreveport, Louisiana.

Oct. 27-29—**Independent Petroleum Association of America,** annual meeting, Statler-Hilton Hotel, Dallas, Texas.

Oct. 28-29—**Third Annual Oil Editor's Conference,** University of Texas, Austin, Texas.

Oct. 28-29—**National Lubricating Grease Institute,** annual meeting, Edgewater Beach Hotel, Chicago, Illinois.

Oct. 28-31—**American Nuclear Society,** 2nd winter meeting, Henry Hudson Hotel, New York City.

Oct. 31-Nov. 1—**AAPG, Mid-Continent** regional meeting, Mayo Hotel, Tulsa, Oklahoma.

Nov. 6-8—**Gulf Coast Association of Geological Societies,** 7th annual convention, Roosevelt Hotel, New Orleans, Louisiana.

Nov. 10-14—**Society of Exploration Geophysicists,** national convention, Statler-Hilton Hotel, Dallas, Texas.

Nov. 11—**API, OIC,** Steering Committee meeting, Conrad Hilton Hotel, Chicago, Illinois.

Nov. 11-13—**Steel Founders' Society of America,** 12th Technical and Operating Conference, Carter Hotel, Cleveland, Ohio.

Nov. 11-14—**API,** 37th annual meeting, Conrad Hilton Hotel and Palmer House, Chicago, Illinois.

Nov. 11-14—**Society of Exploration Geophysicists,** 27th annual meeting, Statler Hilton Hotel, Dallas, Texas.

Nov. 12-13—**API Board of Directors** meeting, Conrad Hilton Hotel, Chicago, Illinois.

Nov. 12-14—**National Association of Corrosion Engineers,** Northeast region, fall meeting, Penn-Sheraton Hotel, Pittsburgh, Pennsylvania.

Nov. 13-14—**Air Pollution Conference,** co-sponsored by Armour Research Foundation and Midwestern Air Pollution Prevention Association, Loop Hotel, Chicago, Illinois.

Nov. 13-16—**National Association of Corrosion Engineers,** Miami Section meeting, Key Biscayne, Florida.

Nov. 22—**Natural Gasoline Association of America,** Panhandle Plains regional, Herring Hotel, Amarillo, Texas.

Dec. 1-6—**American Society of Mechanical Engineers,** annual meeting, Statler Hotel, New York City.

Dec. 2-6—**26th Exposition of Chemical Industries,** New York Coliseum, New York City.

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Oil men serve the nation by unlocking natural fuels from the rocky vaults of the earth. In the vast oil and gas producing fields, these men scientifically drill, transport, process and distribute black gold and blue flame for the fuel needs of our dynamic economy. YOUNGSTOWN steel men join their oil and gas partners in contributing toward progress and an even greater standard of living!

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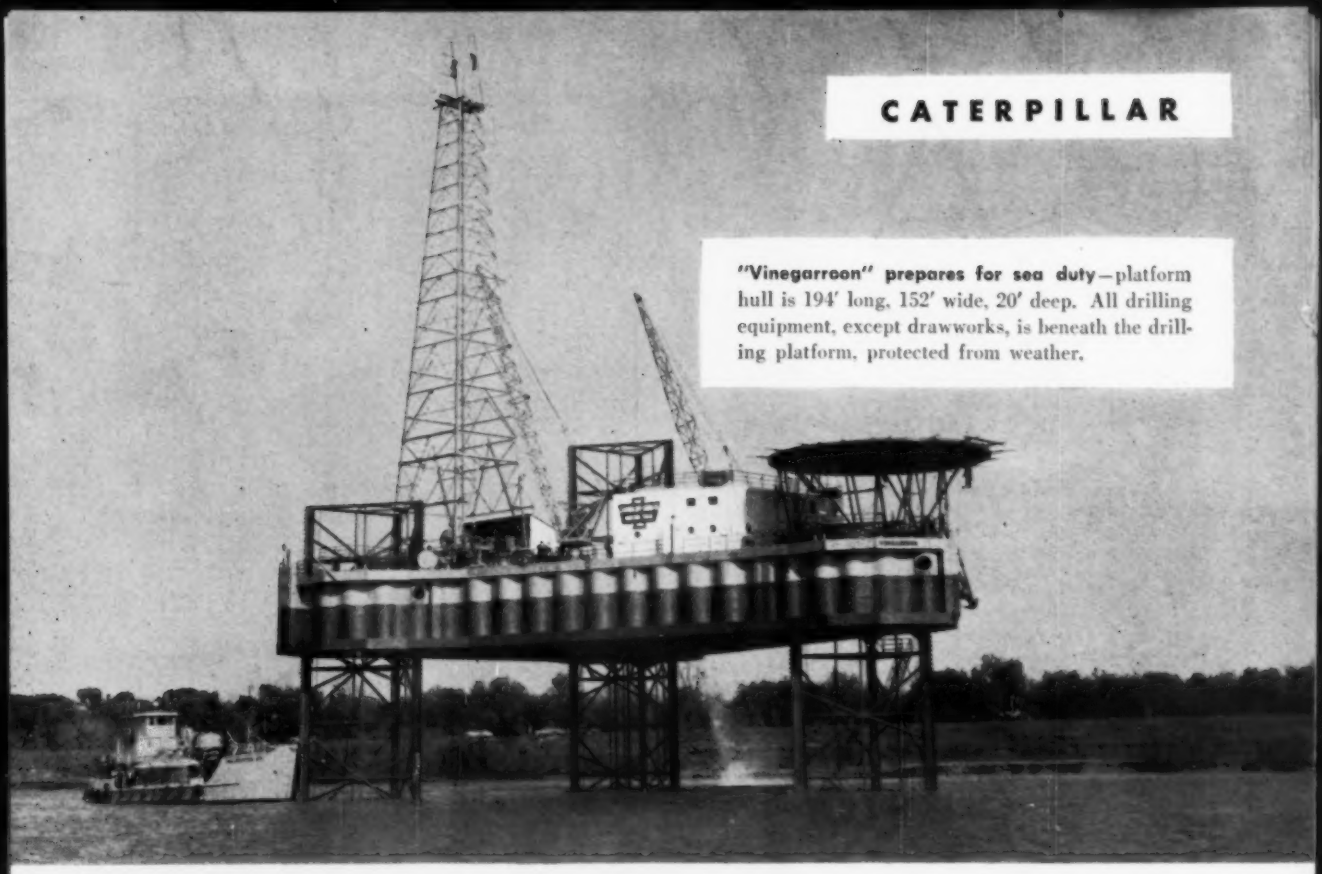
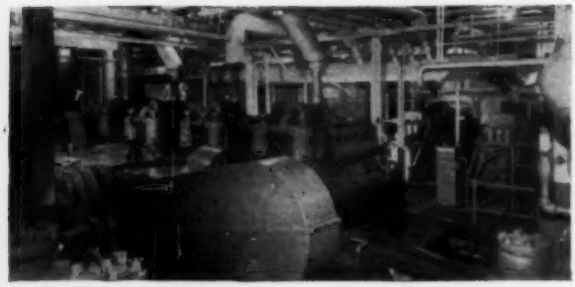


"Vinegarroon" prepares for sea duty—platform hull is 194' long, 152' wide, 20' deep. All drilling equipment, except drawworks, is beneath the drilling platform, protected from weather.

NEW TRIPOD PLATFORM WEATHERS "AUDREY"

The "Vinegarroon" and its seven CAT* Diesel Engines survive hurricane with only minor damage, 15 miles off Cameron, La.



Four Cat D397 Turbocharged Diesels equipped with Twin-Disc torque converters deliver prime power for all drilling operations. Three other D397s (in background) are source of power for lowering and raising the giant legs.

A revolutionary offshore drilling platform withstood the fury of June's destructive hurricane off Cameron, La. With power supplied by seven Caterpillar* Turbocharged D397 Diesels, it was back in operation in days.

The mobile platform is the revolutionary "Vinegarroon"—a 2500-ton, triangular floating barge equipped with three 145-foot legs. The rig, operated by Zapata Off-shore Co., Houston, Texas, was built by R. G. LeTourneau, Inc., of Longview, Texas.

Source of power for the giant legs—made of truss-braced tubular steel—are three D397 Turbocharged Diesels, each rated at 650 HP (maximum output capacity). They drive the generators, which provide the output for 27 electric motors to raise and lower the three gigantic legs. One of the diesel-generator units supplies power for ship's service, as well as acting as standby for the legs.

Feet of the big legs are spud tanks 35 feet in diameter and 32 feet high which fill with water. All three legs can be moved simultaneously.

Once in position, four other Cat D397 Turbocharged Diesels equipped with Twin-Disc torque converters go to work. Through mechanical compounds, these powerful engines drive three mud pumps and an Oilwell model 96 drawworks.

Fifteen miles out in the Gulf where the "Vinegarroon" is drilling, down time can be ruinous. So the engines have to be absolutely dependable. Caterpillar Diesels have written an impressive record of dependability in oil operations around the world.

Your Caterpillar Dealer can show you a full line of diesels with electric sets up to 350 KW (continuous duty) and *certified* power units up to 650 HP (maximum output capacity). You'll find Caterpillar Dealers everywhere . . . ready to give you prompt service with parts you can trust.

Caterpillar Tractor Co., Peoria, Illinois, U.S.A.

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DMS and DME have a reputation in the field for fast, trouble-free deep well-drilling. This is particularly true in mud-making shale formations, and when high temperatures are encountered. DMS inhibits dispersion of drilled clays and shales, and protects producing formations and drilled solids from swelling. Drilled solids are larger and settle in pits faster, resulting in easier maintenance and less barite consumption.

Because of their stability in the presence of different electrolytes, DMS and DME have been used successfully in calcium, sea water, and saturated salt muds. The surfactant additives are not adversely affected by drilled anhydrite and salt.

Overall cost of drilling is reduced by decreased consumption of barite, less mud conditioning time, good formation protection and completion characteristics. This results in faster drilling with more time on bottom and less rig time to completion.

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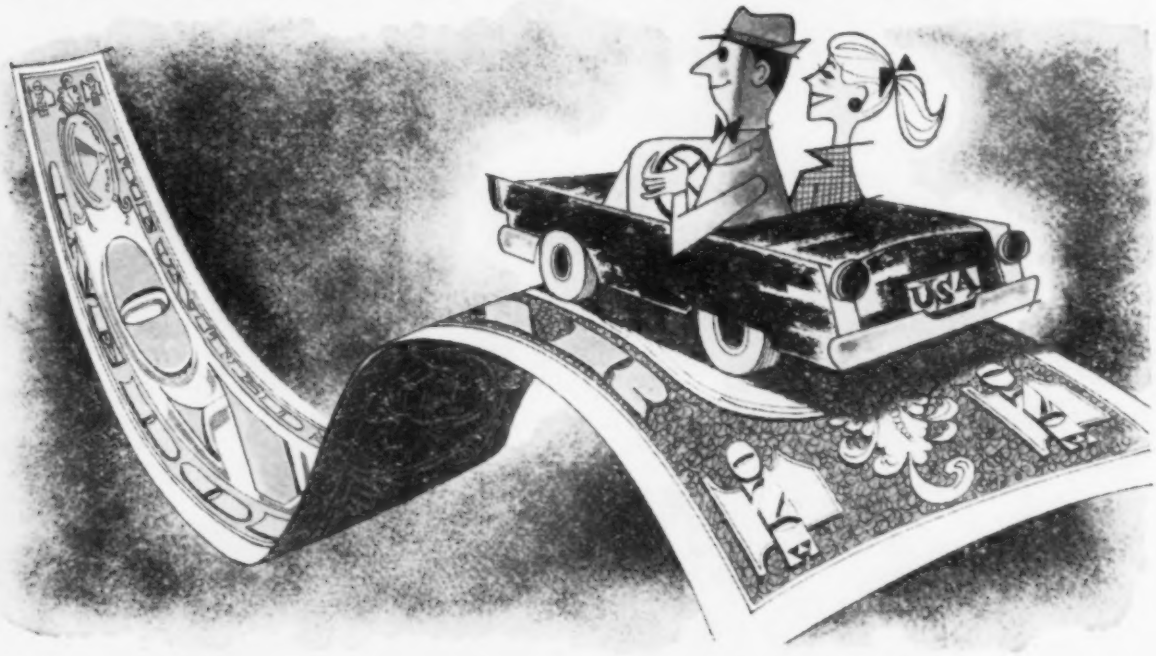
It's surprising how little oil's customers know about the biggest selling petroleum product—gasoline! They never see it or touch it—yet they *use* it every day. All they know is the price they pay . . . and only a few know how big a bargain they really get with today's gasoline.

You'll be helping yourself and your industry by giving oil's customers the *real* story about today's gasoline prices and taxes. Here are the facts:



Today's Gasoline Dollar S-t-r-e-t-c-h-e-s Further

It's a fact that the average American motorist actually gets "more for his money" thanks to the bargain he drives with today's gasoline.

In 1920, one dollar bought over 8 pounds of bread, two pounds of pork chops, two pounds of coffee, and over 20 pounds of gasoline.

Today's dollar buys less than 6 pounds of bread, one and one-third pounds of pork chops, 15½ ounces of coffee. But it buys as much as 28½ pounds or nearly five gallons of top quality fuel —69 miles of driving power! Yes, gasoline still costs less than many other items in the family budget—even though direct taxes add 40¢ to every dollar spent for fuel itself.

America's oil companies have continually fought rising costs so that gasoline prices have gone up only a few pennies in the last five years. Meanwhile, gasoline quality has improved tremendously . . . so that today's *regular* gasoline is as good as premium gasoline was only five years ago. And today's *premium* gasoline is as powerful as the bomber and fighter gasolines of the last war.

You can be proud to be part of an industry with such a fine record of fighting inflation while improving its products. So next time you are asked about gasoline prices, remember . . .

WITH TODAY'S GASOLINE YOU DRIVE THE BEST BARGAIN IN YEARS!

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I would like to obtain more information about today's gasoline quality, prices and taxes. Please send me your FREE booklets.

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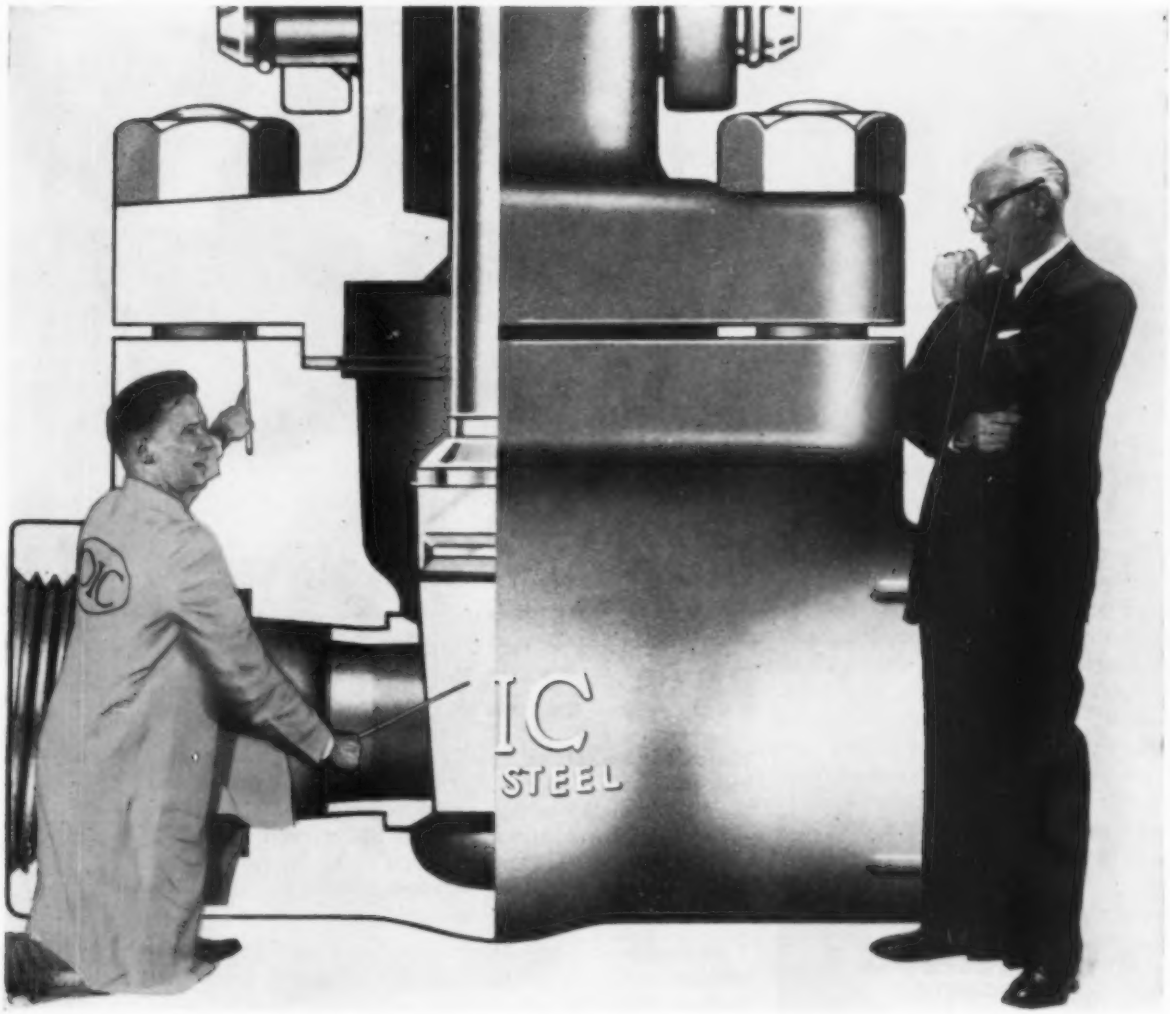
...and you can see here....and here, sir, how we've killed maintenance problems on our new forged steel lines.



We stop galling and erosion by giving you 13% chrome stainless steel trim with wedges *duracased* to a rugged *1000 Brinell hardness.*

The square and *bolted* body-bonnet joint makes it easy to service the valve quicker. And it's a tighter joint, made doubly leakproof by recessing the soft iron gasket into the body. The gasket can't blow!

And you get the fastest joint make-up you've ever seen. Look at those pipe ends. See the extra wrench-gripping area and lugs. See how body-bonnet flanges are out of the wrench's way. No time lost here!

These new 600-lb. OIC forged steel valves are available with either *high-flow* ports (1300 line), or *standard-flow* ports (1100 line). Call your OIC Distributor, or write for specification literature.

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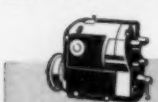
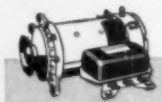
Packed with electrical energy, American Bosch Magnetos kick off FAST – supplying the instantaneous sparks that start Drilling, Pumping, and Pipeline engines FASTER – and keep them running LONGER – even under the toughest working conditions! That's why they're installed as original equipment by so many leading engine manufacturers for Oil Industry services.

Your engines can have this reliable ignition – high or low tension replacements are available for practically every engine. Precision engineering and rugged construction assure full-time, trouble-free operation. Write directly, TODAY; find out how American Bosch Magnetos can improve your engines and operations. American Bosch, Springfield 7, Mass. A Division of American Bosch Arma Corporation.

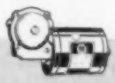
AMERICAN BOSCH


Automotive and Aviation Magnetos


Generators and Regulators

Components for Aircraft Engines

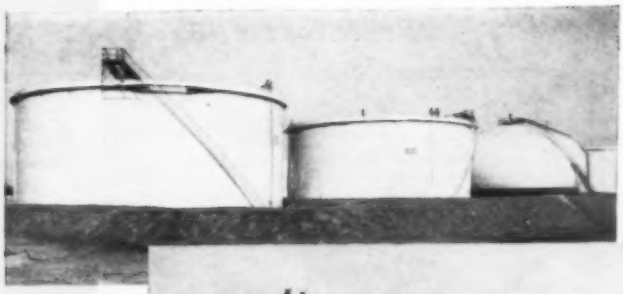
Small Electric Motors


Electric Windshield Wipers

Diesel Fuel Injection Equipment

77

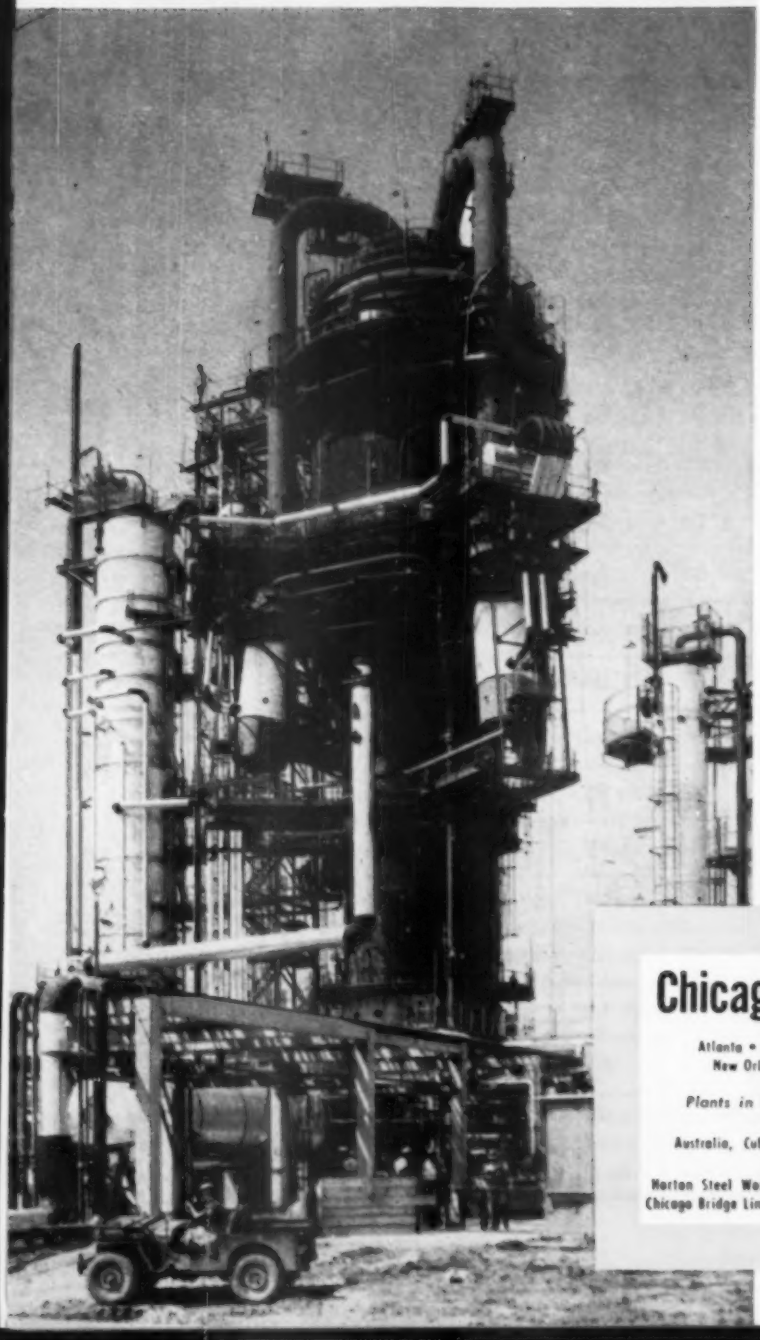
CB&I Structures serve AMERICAN OIL COMPANY at Yorktown, Virginia



Some of the 77 CB&I-built storage and processing structures at American Oil Company's Yorktown refinery include:

Top: Two of 34 Horton® Pontoon Floating Roof tanks, and a 40,000-barrel Hortonspheroid®.

Bottom: 10,000-barrel Hortonspheres®, designed for 75 pounds per square inch butane storage.



When American Oil Company's Orthoflow Fluid Catalytic Cracking unit went on stream in 1956 at their new 35,000-bbl. per day Yorktown, Virginia refinery, it contained a reactor, regenerator, vacuum tower, crude tower, absorber tower and catalyst hoppers fabricated by CB&I and furnished through M. W. Kellogg Company. Extensive storage facilities including 34 Horton® Pontoon Floating Roof Tanks, 28 Horton Cone Roof Tanks, Hortonspheres® and Hortonspheroids® have brought Yorktown's total of CB&I storage and processing structures to 77.

The same CB&I extensive design, fabrication and erection services that have served American Oil Company are available to you. Whether you're expanding, or building new . . . see CB&I.

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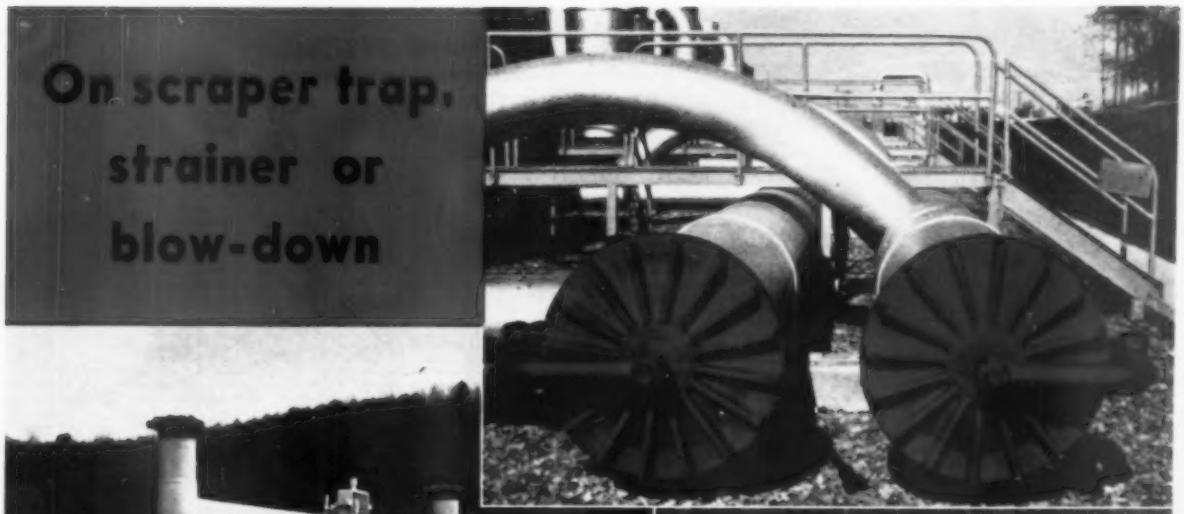
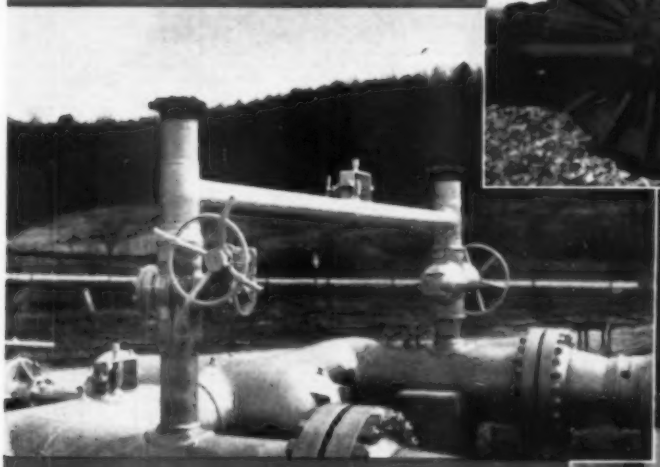
PROPERTIES OF CONSTITUENTS OF NATURAL GASOLINE

Property	Constituent						
	Ethane	Propane	Butane	Iso-butane	Pentane	Iso-pentane	Hexane
Empirical formula	C_2H_6	C_3H_8	C_4H_{10}	C_4H_{10}	C_5H_{12}	C_5H_{12}	C_6H_{14}
Molecular weight	30.05	44.06	58.08	58.08	72.10	72.10	86.11
Specific gravity of gas (A=1)	1.038	1.523	2.007	2.007	2.491	2.491	2.976
Density, gas, lb. per cu. ft.	0.07949	0.11656	0.15365	0.15365	0.19074	0.19074	0.22780
Cu. ft. gas per lb.	12.579	8.579	6.508	6.508	5.243	5.243	4.390
Cu. ft. gas per gal. liquid	39.41	36.42	31 62	30.59	27 58	27.32	24.26
Specific gravity of liquid	0.3758	0.5092	0.5827	0.5637	0 631	0.625	0.663
A. P. I. gravity of liquid	248	146	111	120	93	95	82
Lb. per gal. liquid	3.133	4.245	4 858	4.700	5 261	5 211	5.527
Gal. per lb. liquid	0.319	0.236	0.206	0.213	0.190	0.192	0.181
Boiling point, deg. fahr.	—127.5	—44	30 9	10.0	97.0	82.4	156.0
Melting point, deg. fahr.	—278	—310	—211	—229	—204	—256	—138
Critical temp., deg. fahr.	90	207	304	273	387	370	455
Critical pressure, lb. per sq. in.	723	654	542	536	486	484	435
Specific heat of gas, C_p, B.t.u./lb.	0.505	0.473	0.456	0 462	0.448	0.448	0.442
Specific heat of gas, C_p, B.t.u./cu. ft.	0.0406	0.0566	0.0728	0.0731	0.0854		0.1006
C_p/C_v	1.22	1.13	1.108	1.110			
Heat of vaporization, B.t.u. per lb.	210	182	164	158	154	158	143
Heat of vaporization, B.t.u. per gal.	658	773	797	743	810	823	790
Heating value, B.t.u. per cu. ft. gas	1,795	2,580	3,350	3,266	4,007	4,012	4,730
Heating value, B.t.u. per lb.	21,990	21,300	20,900	20,800	20,900	21,100	20,800
Heating value, B.t.u. per gal liquid	68,600	90,400	101,500	97,800	109,900	109,900	115,000
Lower inflammability limit, %	3.2	2.3	1.9	1 9	1 4		
Upper inflammability limit, %	12.5	9 5	8.5	8 4	8.0		
Mean coefficient of expansion, 0°—50° F.	.0028	.00143	.00096	00118	.00081		.00070
Mean coefficient of expansion, 50°—100° F.		.00180	.00113	00128	.00089		.00078

On scraper trap, strainer or blow-down





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More Safety? Certainly, because the O-Ring seal in 2-Piece Blank Caps has been proved in over eight years of service to provide the safest, tightest seal against gas and liquid. And all subs are forged of finest forging-quality steels to give the ultimate in strength.

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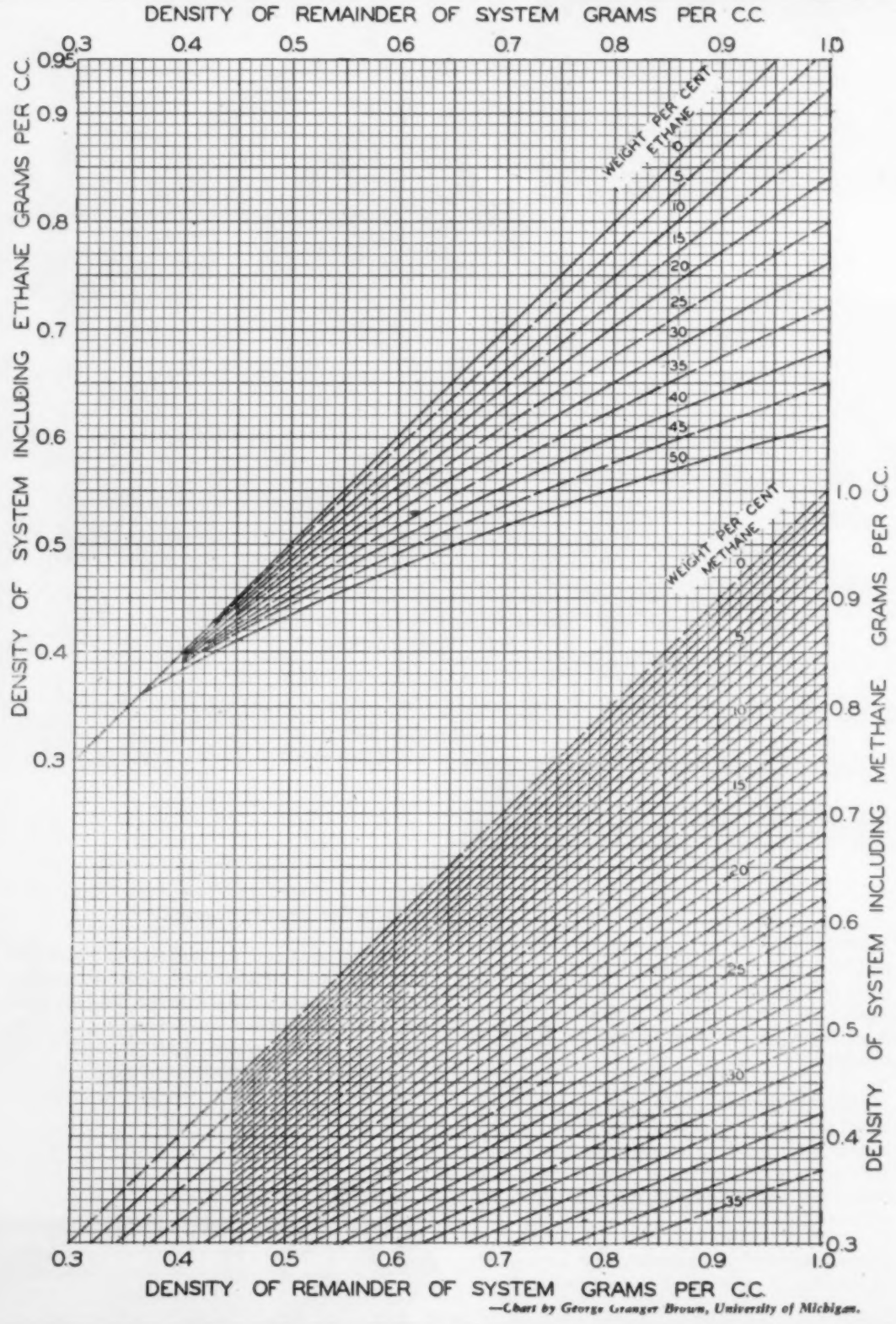

—Chart by George Granger Brown, University of Michigan.

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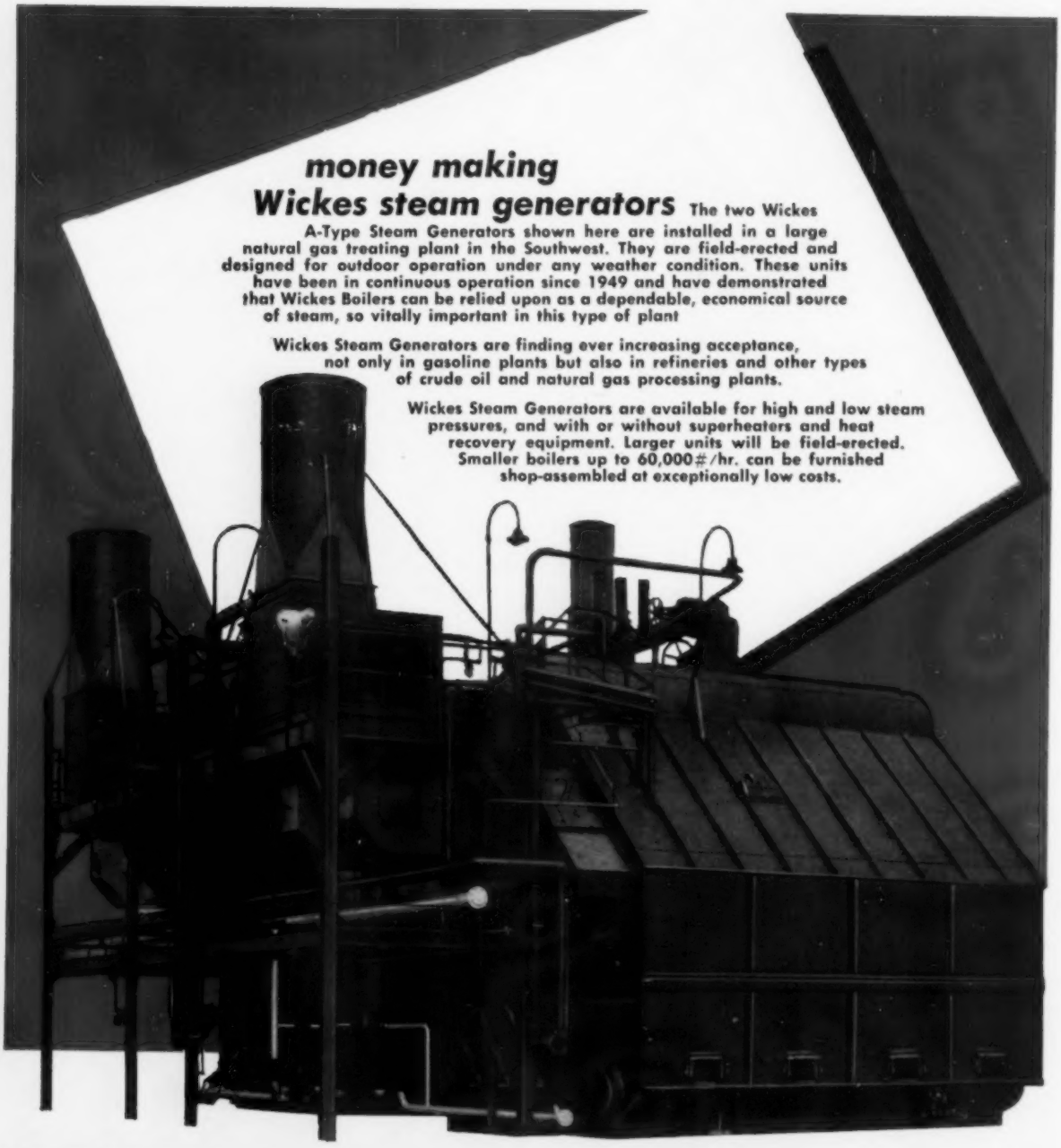

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The two Wickes A-Type Steam Generators shown here are installed in a large natural gas treating plant in the Southwest. They are field-erected and designed for outdoor operation under any weather condition. These units have been in continuous operation since 1949 and have demonstrated that Wickes Boilers can be relied upon as a dependable, economical source of steam, so vitally important in this type of plant

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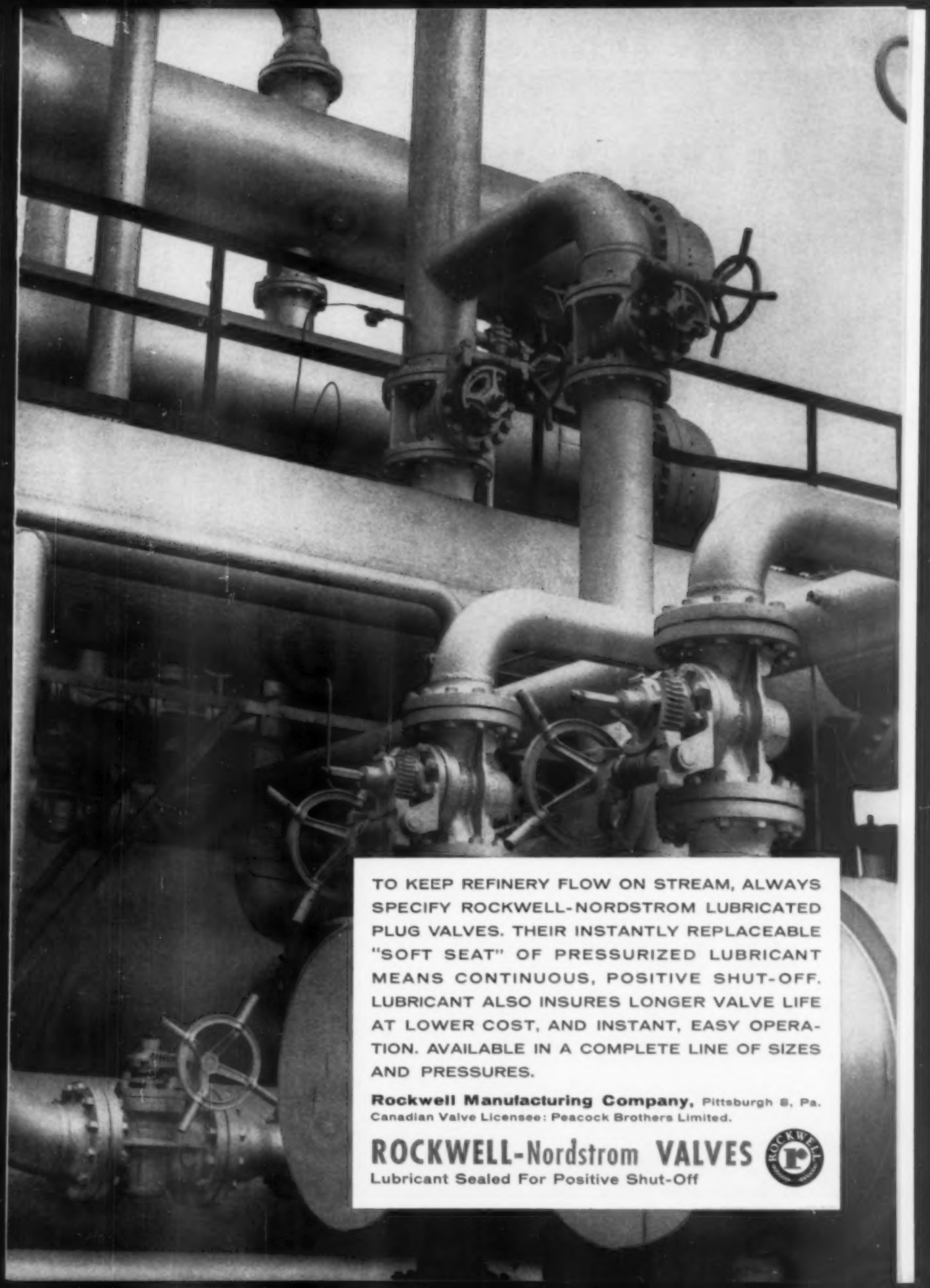

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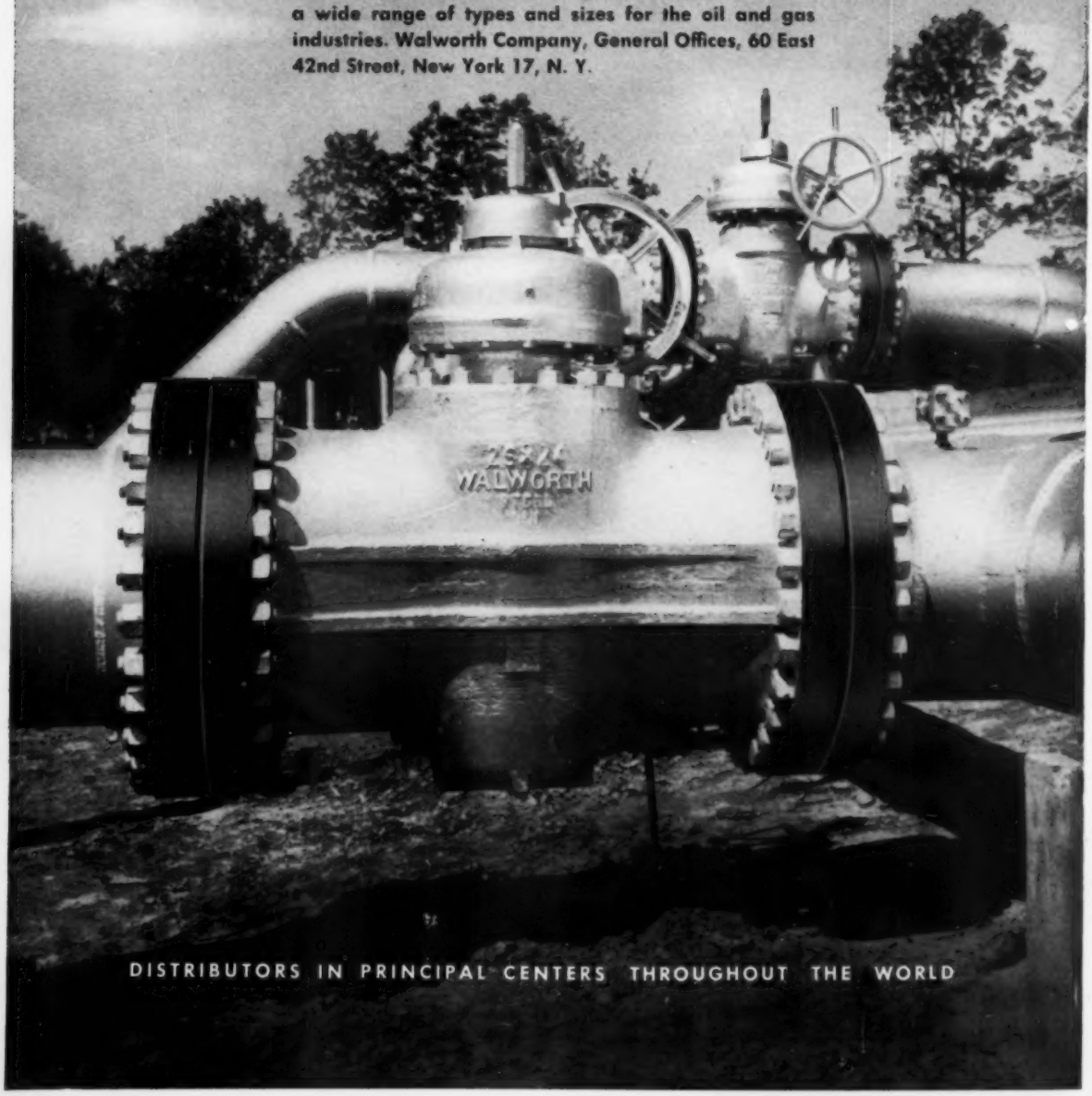

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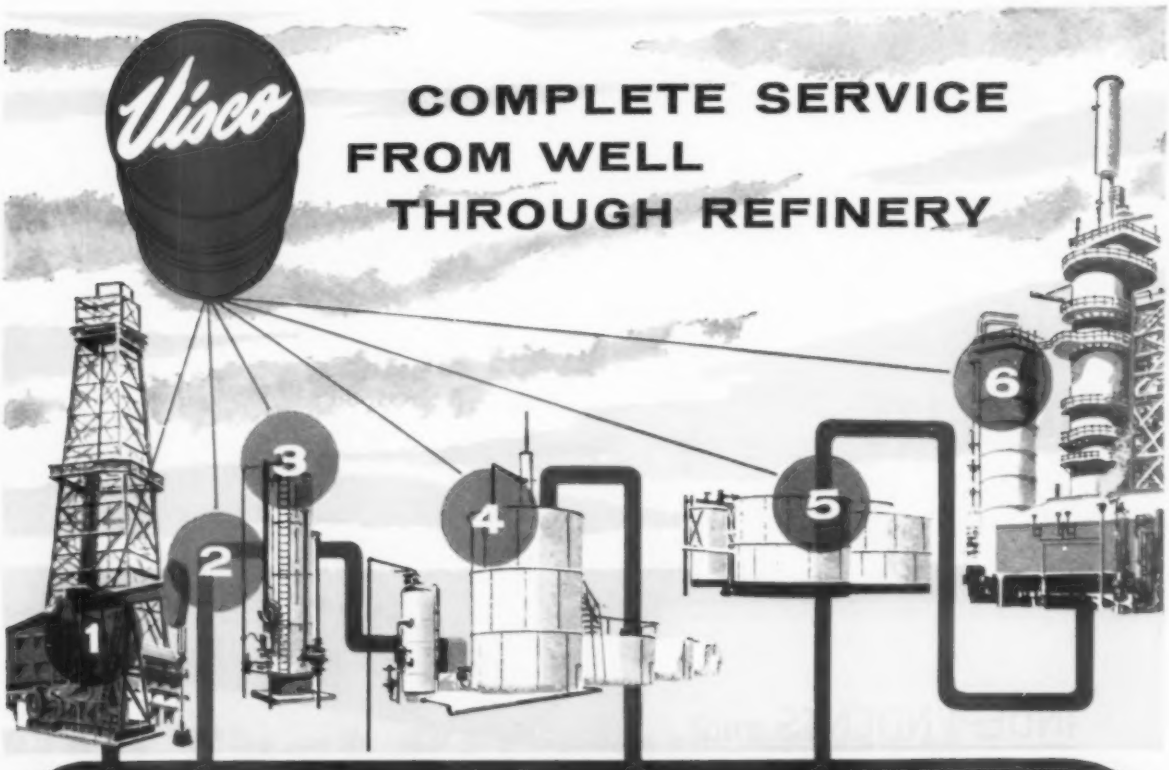

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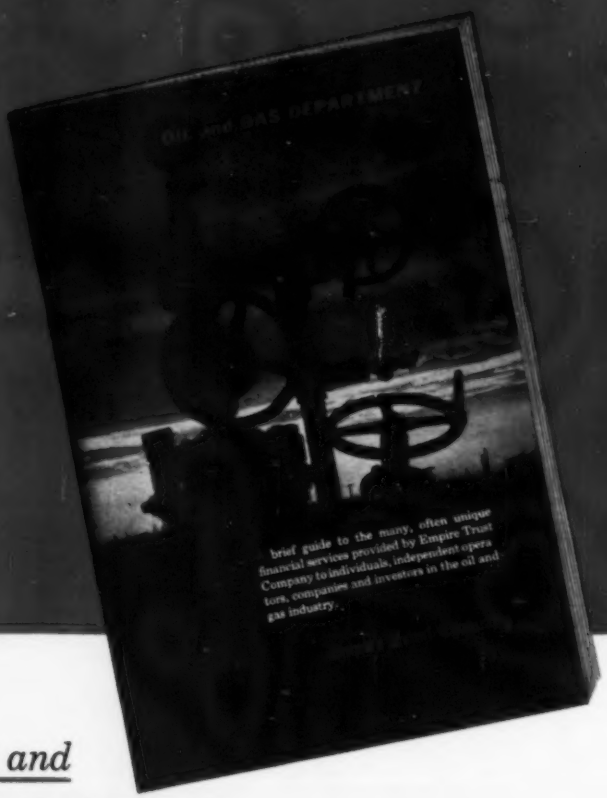
brief guide to the many, often unique
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Use That Printed Word!

DeWitt C. Reddick

TEN years ago Elmer Roper conducted a nationwide poll of workers in industry, professions, and other areas of employment. His findings startled many American industrialists. The poll revealed that *50 percent of the nation's industrial workers found their work dull and uninteresting.*

People in factories, refineries, and other industrial plants generally had no enthusiasm for their daily labor. Thus it was shown that a large segment of the country's wage earners were experiencing daily frustration.

In contrast almost 90 percent of the men and women who work for lawyers, doctors, and executives reported that they enjoyed their work. About 80 percent of those who worked on farms considered their work interesting.

Roper's poll might have gone relatively unnoticed had it not confirmed what management had already been discovering for itself. Studies showed that job dissatisfaction resulted in less work and poor morale.

In the years that followed, America's oil and gas company executives have joined other managements to work out some of the answers. One answer was to overhaul the company publication and make it a key instrument to help re-orient the employee's attitude toward his job.

From a purveyor of miscellaneous tid-bits the company publication has become a well planned and carefully edited competitor with mass media for the attention of employees, management, and strategic elements of the American public.

Let's take a look at oil and gas company publications in 1957. For THE PETROLEUM ENGINEER a questionnaire was sent to 308 editors and staff members and replies received from 76, representing an adequate cross-section. Some of the more interesting findings are as follows:

How Many?

No exact list has ever been compiled of oil and gas company publications in this country, but a conservative estimate would range from 350 to 400. Inland Printer's *Directory of House Organs* lists 315 from 130 oil and gas companies. Staff members from 177 oil company publications attended a single conference sponsored by the Standard Oil Company (N. J.) one summer.

A majority of the large and medium oil and gas companies publish more than one magazine or newspaper. Shell Oil prints 34 and Socony Mobil Oil 31, in addition to foreign publications of each company. Of the 76 companies responding to the questionnaire, 61 percent have more than one publication. Fourteen percent publish more than five.

How Much Do They Cost?

Responding editors showed an average annual expenditure per magazine, exclusive of salaries, of $25,679. One company reported a budget of $515,000 annually for its publications. Another carries an annual budget of $200,000 for company publications. Five companies spend more than $100,000 each on the production of a single slick, four-color internal-external magazine.

Toward the other end of the financial scale are a number of plant and department papers published on budgets of $3000 to $10,000. Total publications expenditures of the 76 magazines represented in the survey was close to $2,000,000. In addition, these same

Dr. Reddick is professor of journalism, University of Texas, Austin, Texas.

companies reported spending $1,250,000 for other publications not included in the above tabulation.

Types

Oil and gas company publications fall into distinct patterns.

1. **External-Internal.** This is generally a four-color magazine, edited with the skill required for a mass magazine combined with a passion for accuracy. It goes to employees, but its basic purpose is to present the company to its customers or to influential persons in industry, government, or civic life.

Examples of such publications are *The Lamp* of Standard Oil of New Jersey, *The Humble Way* of Humble Oil and Refining Company, and Socony Mobil Oil's *Flying Red Horse*.

2. **Dealer.** Dealer publications, generally produced with the help or direction of the marketing division, go to dealers who sell or distribute the company's products. They are filled with sales know-how, information on new products, and reports of successful methods employed by individual dealers. The basic purpose is to help the dealer increase his sales and improve his services. *Selling Sixty-Six* (Phillips Petroleum Company) and *The Spotlight* (Sohio Oil Company) are good examples.

3. **Internal.** Strictly internal publications outnumber the other types three or four to one. These publications — many of which are in newspaper format —are edited specifically for employees. Larger companies generally provide a newspaper for each major division, particularly when divisions are in different geographical locations.

In addition to the three standard types mentioned above, a few companies print magazines specifically for their farm customers.

How Many Readers?

The 76 oil and gas company publications represented in the survey had a total circulation of 968,468, or an average of 12,743. Highest circulation is that of *The Texaco Star*, with 185,000; and next highest was for *The Bulletin* of Standard Oil of California, with 170,000. Majority of the publications, however, are purposely pinpointed for employees in refineries, branch units, or divisions. So 59 percent have less than 5000 circulation.

Total circulation of all oil and gas company publications must remain only a rough estimate. The 76 represented in the survey comprise only a fourth or fifth of the total magazines, yet most of the larger publications were included. A fair estimate would place total circulation of all the oil and gas company publications somewhere between 2,500,000 and 3,000,000.

What Size Staff?

Many companies have an editorial staff of several members who work cooperatively in producing all of the company publications. For example, Humble has an editorial staff of 12 persons. They write and edit the six Humble magazines and in addition prepare most of the brochures issued by the company and do research for company officials. Three of the 76 companies indicated a staff of 10 or more, working in the same office area.

Some of the larger external-internal magazines have staffs who devote full-time to one publication. One such publication listed a staff of five full-time employees.

The typical picture of the smaller publications — particularly the plant and division publications — is that of one full-time editor, with secretarial help, and possibly one part-time or full-time assistant.

What Approach and Purpose?

These company publications, in general, were not as well-staffed or as well-financed when Roper published his poll several years ago. When management set out to solve the problems raised by Roper's investigations, they had to face the challenge realistically.

Esso Standard Oil Company of New York touched off the new note when a company research pamphlet stated in 1949: *"Since favorable attitudes have been found to be the basis for job satisfaction and increased productivity, good communication is a foundation for sound management. Through effective communication, management becomes aware of the nature and potentialities of the work force, what courses of action are available in making decisions, and how the organization may be profitably directed."*

In this same period of industrial reexamination, Edward T. Cheyfitz, assistant to the president of the Motion Picture Association of America, told the American Management Association that management must devise ways of giving to each worker (1) a feeling of having a part — an important part — in the whole enterprise of production, and (2) recognition *as a person*, aided by an atmosphere of friendliness among his associates and in the community.

Cheyfitz continued: *"It* (management) *must adapt to industry, in practical working terms, the concept of the dignity of man. Does the company think it kids the worker when it talks of making him a better employee and means only that it is interested in getting more out of him? Management should be interested in the worker, not only as a more effective producer but as a more effective individual. . . . Does it sound unbusinesslike to say that management has a responsibility for expanding the horizons of man, no matter what his job may be?"*

Recent years have seen efforts to utilize the company publication in expanding the worker's horizons.

Economics: Pro and Con

The trend toward "enlarging the worker's horizons" in relation to his job brought up the question: Should the company publication tackle serious topics of economic philosophy and basic industrial policy? A number of oil company editors heard R. E. Roberts, manager of Ford Motor Company's Employee Relations, tell the Industrial Editors Association of Southern California in 1952:

"How many of our employees understand how wealth is created and distributed; where jobs come from; how productivity determines our standard of living; how wages and prices and profits operate in a free economy? How many of them understand — or appreciate — the freedom of a private enterprise economy as contrasted with the regimentation of a planned or collectivist economy? How many of them realize that they themselves are far better able to provide for their own security than is the government?

"I'm sure that each of you will agree that very few — if any — of our employees understand these things. And the reason they don't is that industry has done very little to tell them about the economic facts of life.

"We in industry have learned how to use every modern tool except language, yet that is the tool our enemies use best."

Objections to such proposals were not long in coming. They centered around these three points of view:

1. Some managements felt that economic problems of the company are no business of the employee and that he should not be encouraged in thinking that they *are* his business.

2. Others, while recognizing that the company economics must concern the employee, believed that employees generally were not able to understand the complex aspects of such problems and would be only confused by their discussion in the company magazine.

3. Editors and management alike warned of the danger that articles on economics and company policies might well be interpreted by their readers as "propaganda" and would breed distrust of the magazines by employees.

These objections were not to be

WHAT PRICE GASOLINE?
TRADING STAMPS vs. MANAGEMENT FOR PROFIT
Baytown BRIEFS
Metal Trades Council Requests Bargaining Rights

Editors now write on subjects that were taboo 10 years ago. Here are three examples of forthright discussion.

taken lightly, for each contained some measure of truth. Yet to prohibit company publications from giving space to such serious questions that are bound to come anyway to the employee's attention from outside sources seemed very shortsighted.

In the five years since Roberts' challenging talk, many editors have experimented with ways of presenting topics that 10 years ago would have been taboo in a company publication.

Glance through oil and gas company publications of the last several months and you will find many examples. For instance:

"The Mystery of Gasoline Pricing" in Sohio's *Progressive Dealer* for May 1956. This article tackles the too-common misconception that uniformity of gasoline prices in a community indicates collusion in price fixing between major companies.

"How Independent is the Independent Shell Dealer?" in *Shell Progress* for October 1955. In a down-to-earth manner this articles explains the precise relationships between Shell Oil Company and the 22,000 service stations through which its gasoline is sold. The article appeared as a Congressional subcommittee was hearing complaints from some dealers charging unfair practices by a few companies.

Shell Progress likewise tackled the critical question of gasoline prices in two articles – "Part I: How Retail Prices are Born" (July 1955) and "Part II: Now, about Price Wars" (April 1956).

"No Profit is BAD BUSINESS" explains the *Atlantic Magazine* for January 1956. The article quotes testimony of the company's general manager of marketing before a subcommittee of the Senate Small Business Committee. Capturing the flavor of a "behind the scenes" news story, the article describes the function of volume production in a competitive economy.

Cities Service *Empire* humanized the company's annual report in two interesting installments.

Oilmanac of Gulf plunged into a difficult subject with an article on "The Depletion Provision" (October 1956). "We've got to make our own employees understand the provision or we can never hope that the public will," an oil company executive commented.

This increasing willingness of management and editors to present basic issues and principles in the company publications is a tribute both to the long-range vision of management and to the editorial skill of the writers.

Better Writing

Writers face the dual obligation of making the articles readable and interesting to laymen and of avoiding exhortation and propagandizing. They have turned to established reporting techniques.

Basic research is essential to concentrate each story on facts rather than opinions.

Interviewing and question-and-answer techniques have opened the way for authorities to shed light on the subject; and frequently the authorities chosen come from outside the company.

Do They Pay?

After a glance at increasing budgets for company publications, a down-to-earth cost-conscious executive may well ask, "Are they worth it?" Obviously, some publications may not be doing the job for which they are intended. But concrete evidence gives a positive "Yes" to the question in most instances. Here are a few examples:

The company magazine can help to pave the way in approaching land owners for leases. Representatives of Pure Oil report that the company publication, in areas where the company does no marketing, serves to "break the ice" and introduce the company to those from whom leases are sought. Humble Oil and Refining men, seeking leases in rural areas, find many farmers already friendly to the company because they have been reading the *Humble Farm Family*.

Atlantic Oil recently purchased Houston Oil Company, merging two groups of employees. One issue of Atlantic's *Producer and Pipeliner* was devoted to introducing Hoco employees to their new boss, Atlantic, and its company operations and objectives. This issue brought such a fine response that another issue devoted space to introducing Hoco employees to Atlantic personnel. Management gave credit to the publication for much help in easing emotional tensions that the merger might otherwise have aroused.

It is a common occurrence for favorable community publicity to result from an article in a company publication. *Transgas* of the Transcontinental Gas Pipeline Corporation periodically devotes a long article to one of the cities along the TransCo route. Advance copies go to the local newspaper and to the Chamber of Commerce. Nearly always the newspaper gives news and editorial recognition to the article. Copies of the issue are then distributed to schools and libraries and city officials. Shamrock Oil, El Paso Natural Gas, and a number of other companies follow a similar practice.

Early in 1956 *Baytown Briefs*, a newsy employee paper for Humble's Baytown refinery employees, gained management's permission to print an AFL-CIO request for bargaining rights, with management's reply, and no editorial comment. Later, when executives of the Baytown Employees Federation filed an unfair labor practices charge. *Briefs* printed the charges and management's reply. In both instances the resulting employee sentiment was in favor of the company. Management credits this impartial news approach with doing much to squelch grapevine gossip against the company.

Magnolia's *Minuteman* began a campaign against absenteeism in Septem-

ber 1956. Prior to the publicity program, about 3.3 percent of Magnolia Refinery's personnel was off the job daily due to "personal illness." By January 1957, it had dropped to 2.5 percent — "an indicated savings for the company of thousands of dollars yearly," according to a report from the company.

Tennessee Gas *Line* played a strategic part in an important finance operation. A new subsidiary of the company was established, and negotiations were under way for its financing. At this time a special article was published in the *Line* showing the new plant, explaining its operation, and demonstrating that it was completely in use. The article provided management with a convenient method of visualizing the plant to financiers. Negotiations were completed satisfactorily.

Sometimes the company publication proves of value in the courtroom. For example, an article in the *Torch*, Standard Oil of Indiana, was introduced as evidence to support the company's right to exclusive use of the Standard name in its marketing territory. This right was upheld by the court.

A special issue on Oil Progress week published by the *Sunoco Diamond*, Sun Oil Company, brought more than 900 unsolicited complimentary letters and requests from 23 schools for more information. Sun Oil's management demonstrated keen interest in company magazines by participating in a "reader impact" study of several Sun publications conducted in an exhaustive manner by the Opinion Research Corporation. Improvements in the magazine resulted from the study.

Continental Oil Company employed a research agency to conduct a poll of employee opinion about the company. The *Conocoan* provided a convenient and effective medium for publicizing results of the poll.

Marked decrease in employee termination rate in the Sunray Mid-Continent Oil Company is credited in part to the thorough communications channel provided by *Sunray News*.

Tidewater Oil Company conducted a survey of dealers and found agreement that articles in *The Flying A News*, going to 6100 dealers, had given stimulating new sales ideas to the readers. Other dealer publications have produced the same enthusiastic response.

Greatest values of the company publication lie in those intangible areas which help to create job satisfaction. Through items in the publication the employee gains an understanding of the importance of his job in relation to the overall operation. He is drawn into closer personal ties with his fellow workers in remote parts of the company.

Periodically, he has explained to him his accumulating employee benefits, is warned about safety regulations, is congratulated on prize-winning suggestions, is pictured receiving a long-time service pin. Even his wife and children, through the medium of the company publication, can share in the work-day world of the man of the house.

Problems Today

Though much progress has been made, there is still pioneering to be done on the oil and gas company publication. The 76 editors responding to THE PETROLEUM ENGINEER's survey agreed on three major problems as being their most perplexing:

How to find the time to do their work well. Publishing a magazine which has depth and perception, along with human interest and reader appeal, demands much more time for planning, rewriting, editing, and polishing than was required of yesterday's company publications.

Increasingly, the talents of the editor are being found useful in other capacities — preparing company brochures, writing speeches for executives, doing research on company problems, polling employee attitudes in order to interpret them to management, and writing publicity releases for the daily press. Do editors like their new duties? Most of them are emphatically pleased — the new duties, they realize, open doors to promotion. But they would like to have more help for the routine editorial duties.

How to work more effectively with management. In most instances relationship patterns between management and editor have grown up according to the exigencies of the situation, with little or no thought given to the phychological or philosophical factors that will produce the best for the company. Editors point to their relations with management as one of their most perplexing areas.

Processes of getting approval on articles in many instances are unnecessarily cumbersome and are established for the convenience of management with little recognition of the strategic importance — from the viewpoint of reader confidence — of publication deadlines. This problem is aggravated by a few editors who prefer haste to accuracy.

Editors too often are given the task of interpreting policies when they have no acquaintance with the thinking behind those policies or the discussions and exchange of viewpoints which occurred in executive conferences out of which the policies emerged.

Sometimes editors are not informed of changes in policy until some article, already far along in preparation, runs afoul of the new viewpoint. Editors in general believe that the more they are kept abreast of changing company policy and planning the better they will be able to translate these policies and plans into readable editorial copy.

Some companies meet the problem this way: Editors are invited to sit with management in a few strategic discussions. For continuous communication between management and the senior editor, one director is given major responsibility for internal and external public relations. He maintains close contact with the senior editor on management's thinking. In turn, he can expedite approval procedures for editorial copy and becomes sufficiently informed about aims and objectives and procedures on the company publication to speak about them at directors' meetings.

Efforts are also underway to set up regional and national conferences at which senior editors and management representatives will sit together to discuss major problems of the oil and gas industry and to consider how the company publication can help in facing the problems.

How to cover news from widespread plants and divisions. This is one of the oldest problems of the company publication, and no sure-fire answer has been evolved. General practice is for the editor, with the help of company supervisors, to select a correspondent for each branch or unit, and try to turn him into a reliable reporter.

The Beacon of Ohio Oil Company is a highly personalized magazine with many correspondents. The June 1957, issue manages the astonishing feat of mentioning by name 651 employees and members of their families in an interesting manner.

By-lines, "best correspondent" awards, reminder letters, printed forms to stimulate completeness and accuracy in gathering facts — all such devices have been tried valiantly to stimulate the correspondent's interest. In some instances they succeed; in others they don't. The majority of the editors responding to the survey resignedly indicate that they will continue to struggle with this problem.

In the 10 years since Elmer Roper took his poll of attitudes of America's working population, many changes have taken place in company publications. Oil and gas company publications have been the leaders in giving stature and dignity to the company magazine. It is safe to say that these publications have played a significant part in giving the working man a greater understanding of his company.

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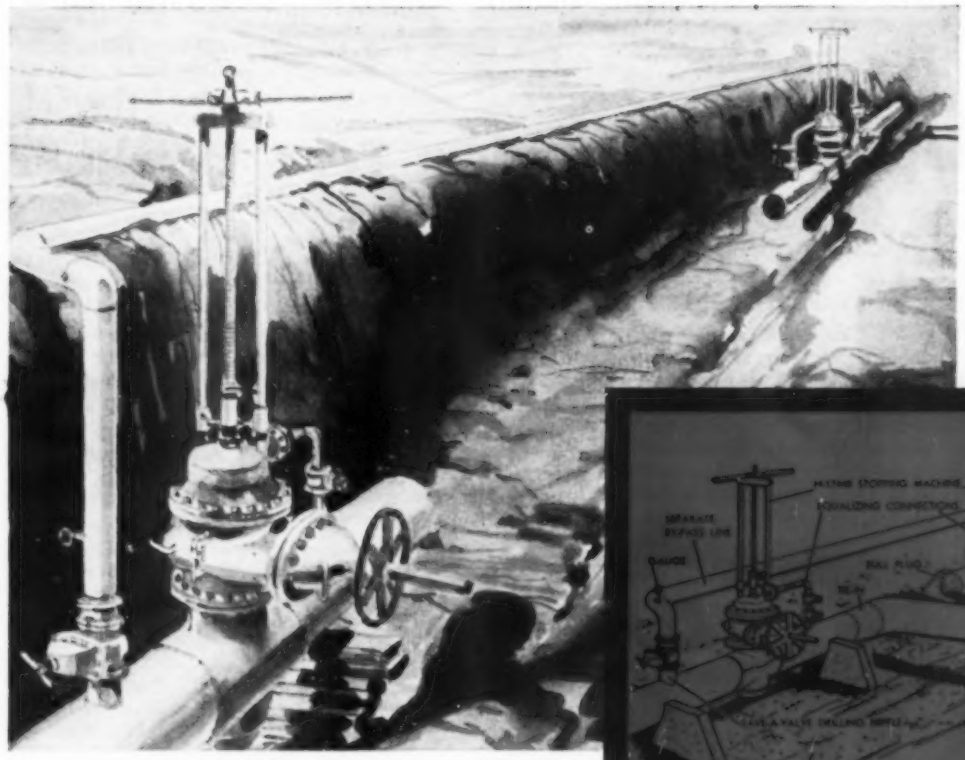

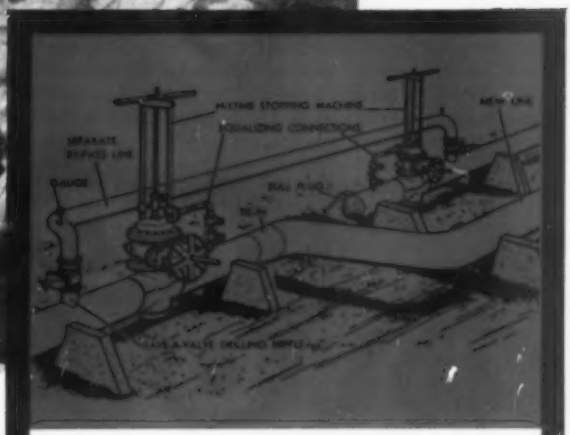

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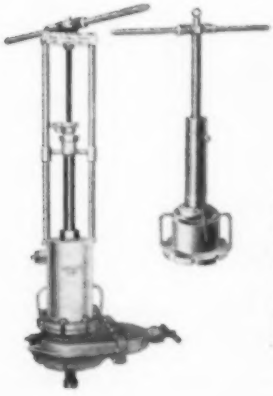

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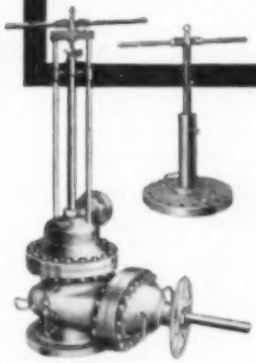

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Industry Moves Ahead in Free World

IN 1956, a year of strong cross currents — rising demand, expanding inventories, countinuing stiff competition, closing of the Suez Canal and political unrest in some Middle East countries —the Free World petroleum industry increased operations from 1955 as follows: Crude oil production 7.9 percent, refinery runs 8.7 percent and petroleum demand 7.4 percent. Prices in general were slightly better than in 1955 but the changes lagged behind rising costs. Early in 1957 a general advance occurred in the prices of crude oil and refined products in the United States as well as in a number of producing and consuming areas abroad.

Demand

The consumption of energy in the Free World increased more than 5 percent over 1955, reflecting improved business conditions in the United States and continued industrial expansion abroad. Petroleum supplied about 39 percent of the total energy used. Substantial capital investments made by the industry during the last five years have contributed to the Free World's economic growth.

The use of petroleum on a world-wide basis totaled about 15.6 million bbl per day in 1956, a gain of 7.4 percent over the 14.5 million bbl consumed in 1955. In Free Foreign countries demand showed an increase of 12.7 percent as compared with 3.5 percent in the United States and accounted for 72 percent of the growth in volume. Estimated consumption for the two periods is shown in the following tabulation:

	1956 Thous. bbl per day	1955 Thous. bbl per day	Percent change	1956 Percent of Total	1955 Percent of Total
United States	8,757	8,460	+ 3.5	56.3	58.4
Other Countries	6,793	6,025	+12.7	43.7	41.6
Total	15,550	14,485	+ 7.4	100.0	100.0

While the demand for all major products was at higher levels, the pattern shifted somewhat in 1956 with the use of middle distillates and residual fuel oil rising substantially, particularly in Western Europe. The estimated consumption of products in the Free World was distributed as follows:

	1956 Thous. bbl per day	1955 Thous. bbl per day	Percent change	1956 Percent of Total	1955 Percent of Total
Gasoline	5,400	5,165	+ 4.5	34.7	35.7
Middle Distillates	3,750	3,440	+ 9.0	24.1	23.7
Residual Fuel Oil	3,935	3,600	+ 9.3	25.3	24.9
Other Products	2,465	2,280	+ 8.1	15.9	15.7
Total	15,550	14,485	+ 7.4	100.0	100.0

The closing of the Suez Canal had an immediate impact upon the consuming countries in Western Europe. Under normal conditions this area draws about 75 percent of its oil supply from the Middle East. The companies with producing and refining operations in the Western Hemisphere were able to make available large volumes of crude oil and refined products for shipment to Europe, thus helping to alleviate the shortages created in that area. Consumption was not curtailed in the United States because the domestic industry had adequate stocks and reserve producing capacity to meet the emergency.

Largest oil consuming countries, excluding United States, based on domestic demand in 1956 are ranked thus:

	Thous. bbl per day	Percent of Total
Canada	720	10.6
United Kingdom	625	9.2
France	440	6.5
Western Germany	325	4.8
Italy and Trieste	280	4.1
Japan	255	3.8
Mexico	245	3.6
Argentina	240	3.5
Brazil	200	2.9
Other Countries	3,463	51.0
Total	6,793	100.0

Production and Reserves

Crude oil production in the Free World averaged 14.8 million bbl per day in 1956 or 7.9 percent higher than the output of 13.7 million bbl for the previous year. All the important producing countries showed an expansion in operations. Distribution of the estimated total by principal areas is presented below:

	1956 Thous. bbl per day	1955 Thous. bbl per day	Percent change	1956 Percent of Total	1955 Percent of Total
United States	7,151	6,807	+ 5.1	48.3	49.6
Venezuela	2,458	2,158	+13.9	16.6	15.7
Canada	470	355	+32.4	3.2	2.6
Mexico	248	245	+ 1.2	1.7	1.8
Other Countries	374	336	+11.3	2.5	2.5
Western Hemisphere	10,701	9,901	+ 8.1	72.3	72.2
Middle East	3,484	3,281	+ 6.2	23.6	23.9
Far East	406	380	+ 6.8	2.7	2.8
Other Countries	204	151	+35.1	1.4	1.1
Eastern Hemisphere	4,094	3,812	+ 7.4	27.7	27.8
Free World	14,795	13,713	+ 7.9	100.0	100.0

It should be noted that the United States share in 1956 was reduced for the second successive year to less than 50 percent of the Free World output.

The Iranian "Consortium" now consists of 8 international companies — 5 American and 3 European —and a group of 9 smaller American enterprises. Production during 1956 exceeded the minimum originally set in the Agreement despite the blocking of the Suez Canal. Crude oil production rose from 360,000 bbl per day in January 1956 to 636,000 in October and averaged 541,000 for the year compared with 328,000 in 1955. A portion of the increase was reflected in higher throughput at the Abadan refinery where runs averaged 232,-

Taken from "Annual Financial Analysis of the Petroleum Industry, 1956," by Frederick G. Coqueron with Norman J. Anderson, David P. Haskell, published by Petroleum Department, The Chase Manhattan Bank, New York.

000 bbl per day in 1956 compared with 152,000 during the previous year.

The factors contributing to the expansion of oil operations in Canada during 1956 were: Development of export markets for crude, addition to crude reserves due to new discoveries in Alberta and Saskatchewan, continued investment of United States funds in established companies and commencement of the Trans-Canada gas pipeline project.

In the Middle East crude oil production averaged 3.7 million bbl per day during the first ten months of 1956 and 2.3 million bbl for the last two months. This area, which contains 70 percent of the Free World's proved crude oil reserves, produced only 24 percent of the total output during the year.

The estimated proved crude oil reserves, excluding natural gas liquids, amounted to 200 billion bbl at the end of 1956. Allocation by major areas is given in the following tabulation:

	Billion Bbl	Percent of Total
Middle East	140.0	70.0
United States	30.5	15.3
Venezuela	14.0	7.0
Far East	6.0	3.0
Canada	4.0	2.0
Mexico	2.0	1.0
Other Countries	3.5	1.7
Total	200.0	100.0

During 1956 the Venezuelan Government awarded concessions to the petroleum industry for the first time since 1945. Several operating companies, as well as a number of new enterprises, were successful in acquiring exploitation concessions in Lake Maracaibo, together with exploration concessions along the international boundary with Colombia. The combined outlay for various blocks of acreage exceeded $300 million.

Several other foreign countries adopted laws in 1956 encouraging development of their petroleum resources by outside capital. This policy resulted in greater competition for concessions in the more promising areas and also expanded the number of participating companies.

Refining

Crude runs to stills in the Free World amounted to 14.7 million bbl per day in 1956 compared with 13.6 million bbl in 1955, an increase of 8.7 percent. Distribution of the estimated throughput by major areas is detailed in the following tabulation:

	1956 Thous. bbl per day	1955 Thous. bbl per day	Percent change	1956 Percent of Total	1955 Percent of Total
United States	7,937	7,480	+ 6.1	53.9	55.2
Caribbean	1,553	1,429	+ 8.7	10.5	10.5
Canada	630	530	+18.9	4.3	3.9
Mexico	217	214	+ 1.4	1.5	1.6
Other Countries	396	336	+17.9	2.7	2.5
Western Hemisphere	10,733	9,989	+ 7.4	72.9	73.7
Western Europe	2,279	2,095	+ 8.8	15.5	15.5
Middle East	905	795	+13.8	6.1	5.9
Far East	752	619	+21.5	5.1	4.5
Other Countries	61	52	+61.5	0.4	0.4
Eastern Hemisphere	3,997	3,561	+12.2	27.1	26.3
Free World	14,730	13,550	+ 8.7	100.0	100.0

Free Europe ranks second to the United States as a refining center. Since only a small volume of crude oil is produced locally, almost all of its refinery requirements must be supplied from other producing areas. In 1956 about 77 percent of the total crude processed by its refineries came from Middle East countries.

The supply of most products, particularly gasoline, was ample to meet requirements, except in countries affected during the latter part of the year by the Middle East crisis. Facilities were added to many foreign refineries for improving the quality of motor fuel.

Tankers

The rapid growth of energy requirements of the Free World and the development of new sources of crude oil supplies in many areas since the close of World War II have placed heavy demand on the industry's transportation facilities. The Free World's tanker fleet was further expanded in 1956 by the delivery of 131 tankers with a combined deadweight tonnage of 3.5 million tons. Over-all facilities amounted to over 42 million tons at the year end, excluding vessels owned by governmental agencies. As a result of increased operating and construction costs, nationalization of the Suez Canal and subsequent blocking of these facilities and damage to the IPC pipeline system, tanker freight rates advanced to record levels during 1956 from those established in 1955. Total tonnage on order at the end of March 1957 approximated 36 million tons scheduled for delivery over a period of years.

Marketing

In the last decade the industry has vigorously stepped up its activities covering development of crude oil reserves and construction of new refineries in many parts of the world. This program has resulted in considerable reserve capacity and, though it affords a valuable margin for use in emergencies, as in the case of the Suez Canal incident, has greatly sharpened competition for markets.

The petroleum industry is not only integrated by departments but also by areas, and markets must be linked to sources of supply. The relation of crude oil production to consumption by areas for 1956 is shown in the following table:

	Production*	Consumption	Excess of Production
	Thousand bbl per day		
United States	7,939	8,757	— 818
Canada	484	720	— 236
Venezuela	2,465	150	+2,315
Other Countries	651	1,215	— 564
Western Hemisphere	11,539	10,842	+ 697
Western Europe	232	2,835	—2,603
Africa	40	450	— 410
Middle East	3,451	380	+3,071
Far East	411	1,043	— 632
Eastern Hemisphere	4,134	4,708	— 574
Free World	15,673	15,550	+ 123

*Includes natural gas liquids.

The movement of crude oil and products between the United States and Free Foreign countries, based on 1956 operations, is analyzed below:

	United States	Free Foreign
	Thous. bbl per day	
Domestic Use	8,757	6,793
Exports	429	1,461*
Total Demand	9,186	8,254
Crude Oil	7,151	7,644
Nat. Gas Liquids	788	90
Total Supply	7,939	7,734
Excess Demand over Production	1,247	520
Inventory Change	+ 179	+ 25
Imports from Other Areas	1,426	545*

*Includes exports to and imports from Soviet controlled countries.

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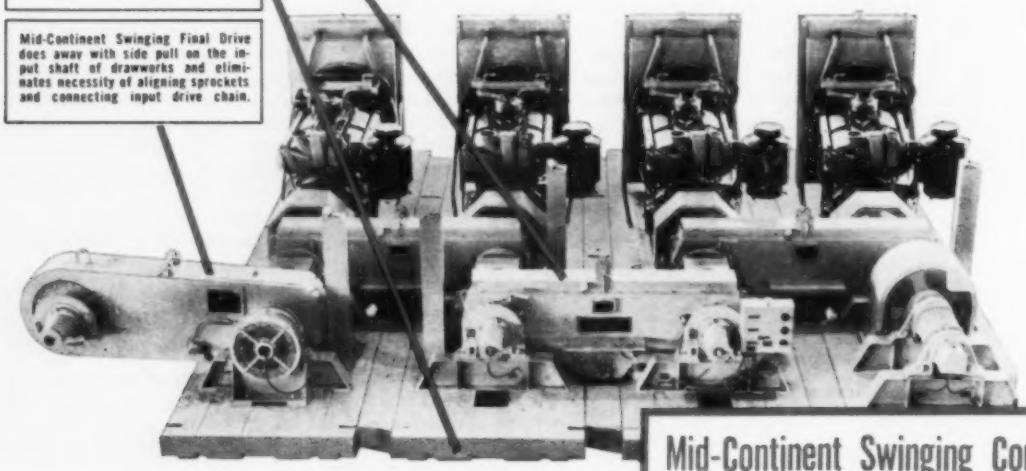

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INCREASING number of variables to be dealt with in decision-making is the ever growing burden of middle and top management... Operations Research helps rule out the all too common crisis management... Here the author tells

...How Operations Research Works

Gilbert C. Jacobus

MANAGEMENT'S job is to push back limitations, to convert difficulties into opportunities. To a very large degree managers accomplish this through decisions. The far reaching impact of management decisions today, both in point of time, and of the scope of human and physical resources affected, emphasizes the importance of a scientific approach.

Can Operations Research really aid in this?

Research in Practice

In the first place, the fact that Operations Research is a relatively young but rapidly growing area of activity is important to remember. The contention is already being made that it is, or is becoming, a science in the United States. It's true that early work in this field has been done primarily by physical scientists and mathematicians. Skills and interests of such people are reflected in developments that have taken place. In the past decade, however, many others have entered the field, including engineers, statisticians, and logisticians. The availability of electronic data processing machines has been a major boon.

One of the great potentialities of Operations Research is an insistence upon the scrutiny of all relationships affecting a problem. For example, in establishing a plan of research to spearhead the development of a supply system that will meet the needs of U. S. Army field commanders in 1965 to 70, a detailed examination has been necessary in regard to essential elements as related to each echelon of command, reaching from the small unit in the field to the Deputy Chief of Staff for Logistics.

Thus was created a block diagram (or matrix) which provides a springboard for and a control over planning for detailed research and development tasks. In this block diagram, the rows were labeled according to levels of command, totaling some 15 in all, and the columns were headed as follows:

I. What is Done

Column 1:—Actions which take place.

Column 2:—Decisions to be made.

II. How This Is Done

A. By means of management system.

Column 3: — Command chain.

Column 4:–Guidance received.

Column 5:–Guidance given.

B. Through information transfer.

Column 6: — Supply action information (both incoming and outgoing).

Column 7: – Management data (both incoming and outgoing).

Column 8: — Records maintained.

C. Column 9:—Through the flow of things (both incoming and outgoing).

D. Column 10:—By the use of facilities.

E. Column 11:—By the use of skilled people.

F. Column 12:—Indicators of volume.

Having analyzed in detail each of these elements at each level of command, a brief descriptive statement was prepared for each point in the block diagram. Those statements indicate what takes place in the system at each point corresponding to where the entry appears in the diagram, and give essential relationships with other parts of the system.

Basic Theoretical Approach

In subsequent research and development for individual elements of this proposed supply system, various methodologies provide means through which specific solutions are accomplished. The basic Operations Research approach finds constant application. In essence this involves first formulation of the problem. Here specific goals to be attained must be determined and restrictions to be met must be identified. The measure of efficiency relative to each goal must be defined.

The second step is the construction of a "model" to represent the part of the system under study. Essentially a model is a representation which portrays conditions or constraints that will govern decisions to be made.

This is where the technician in Operations Research begins to lose the manager for the simple reason that the technician invariably comes up with a mathematical matrix, which is an ordered arrangement of mathematical quantities usually in a square or cube pattern so that the elements occupy set positions in columns and rows.

Having developed a model, the next step is the derivation of a solution by determining the values of control variables that result in maximizing the system's effectiveness. The computed results can then be checked by comparing what happens in practice against that which the computation has led us to expect.

Since conditions seldom remain static very long, a final step is necessary to develop means by which significant changes will be noted when they occur in variables or functions on which solution of the model depends. When such changes do occur, of course, the solution has to be modified.

Industrial Applications

Recently throughout industry con-

siderable experimentation with application of some of the newer mathematical approaches has taken place. Application of such things as probability theory, queuing theory, and correlation and linear programming techniques has grown substantially. Managers aren't expected to be proficient in the detailed application of these approaches but ought to be able to recognize the value of results achieved through them.

Probability theory has been used for a long time in the solution of practical problems. One of the most common applications has been in the actuarial field. Life insurance actuarial tables — expressions of the probability of living — we all know play a major role in the determination of insurance premium payments.

The actuarial approach is used also for the derivation of depreciation rates. The problem here is, of course, one of dealing with a given set of restrictions and a large number of variables derived from a mass of data relating to facilities. Such an approach aids in arriving at valid cost figures, determining taxes and, hence, developing accuracy in the profit figure.

There are other areas in which the actuarial approach has been used. One is in planning for payment of lay-off allowances in cases where an employee leaves the payroll through no fault of his own. A second is the determination of pension costs, something that is of growing importance to many industrial enterprises.

Queuing theory is primarily applicable to problems involving the amount of facilities to be employed. Usually such problems are termed "waiting-line" problems. The application of this approach aids in dealing with situations where elements arriving at a point are required to wait before disposition can be accomplished.

Alternatively, of course, with an excess of facilities, elements arriving are disposed of immediately but there are always some facilities idle waiting for something to arrive. Such situations occur at transportation terminals, retail outlets, packaging points and production lines.

Correlation techniques are devices for expressing the degree of causal relationships existing. If the owner of a corner gasoline station finds he sells more gas consistently on days when the sun shines than he does when it rains, he'll be convinced there's a correlation between sunshine and gas sales. One company has used correlation techniques in aid of projecting such elements as customer demand, long-range employment needs and raw material requirements.

Linear programming essentially is a method for dealing simultaneously with a number of variables for the purpose of calculating the most desirable solution within stated restrictions. This approach is an aid in arriving at such decisions as, what items to manufacture in what quantities, or what suppliers should ship how much to which plants, or which plants ought to ship what quantities in what product mix to which markets.

This methodology is powerful enough, and flexible enough, to be able to offer management a range of decisions based upon varying limitations. It will also bring to light the impact of changes in limitations so that the desirability of modifying one or more of the limitations themselves can be judged.

Such results can readily be understood by managers even though they lack special mathematical training, for essentially this is a system to aid in identifying the most attractive course or courses of action in a given situation. The mathematician can interpret the results of linear programming solutions for the manager, if they have developed a capability to communicate with each other.

Managerial Problems

One of the reasons managers find such techniques difficult to follow, lacking knowledge of advanced mathematics, is the complexity of our modern business problems. For example, one concern faced the need for decision in relation to a situation affecting in the neighborhood of 400 products where variations in both prices and transportation costs were possible.

Solution of this problem in complete detail required simultaneous treatment of more than 10,000 variables. This was beyond the capability of human clerical effort. It wasn't even profitable to attempt to deal with the complete problem through electronic computers.

By ruling out certain details in the solution, however, details which judgment dictated to be not too important, the number of variables was reduced to some 4500. In terms of electronic computer capabilities this then became a management problem for the mathematician, being solved by a medium-sized computer in one working day after inputs were loaded into the machine. A large computer probably could have solved this problem in no more than an hour.

In a particular situation in the General Electric Company a problem was solved "involving 150 simultaneous equations, with a possibility of 150 elements within each equation."[1] Operations Research technicians can thread their way through such a maze of computation. Most managers, however, find attempting to cope with 4500 or more variables in arriving at a decision to be a veritable nightmare.

For managers this problem of an increasing number of variables to be dealt with in decision-making is an ever-growing burden as one approaches higher middle management and top management. In enterprises such as large oil companies the situation becomes acute. Although in the main petroleum business products are not too numerous, and they remain closely interrelated in production and sales, the petrochemical lines bring new complications. Here there are a greater number of different products, with many more in the offing through research and development, and markets are more diversified.

Information for Managerial Decisions

Essentially the manager's business life is a matter of ever-continuing choices. Needs of today and tomorrow must be related to those of the near and distant future. Balance must be maintained among the several segments and functions of the organization. Recurring crises must be eliminated so that people can get ahead of the job to guide it, rather than being constantly in the position of reacting to circumstances already in force.

Crisis management, or pressure management, is far too common. This can be ruled out only through adequate planning. And adequate planning requires thorough analysis for the setting of sound objectives. In any business where setting objectives becomes a team proposition, all members of the executive team require comparable information, preferably with important interrelationships spelled out and highlighted. Then the full impact of management decision is readily discernible by the entire group.

Information is specifically the manager's major instrument for the accomplishment of his prime responsibilities. But in this modern age, raw information is often of little value. Data needs to be manipulated, refined, important relationships indicated and logical conclusions not only derived but also presented in a form understandable by the manager. Operations Research techniques can be a mighty tool in aid of, but will never be a substitute for, human judgment. Operations Research can serve the manager by providing the kinds of information he needs in a form usable for modern decision-making.

This is the second of three articles on the subject.

[1] "The Purpose of Operations Research and Synthesis in Modern Business," Carl W. Germeck, Consultant, Operations Research and Synthesis Consulting Service, General Electric Company, published in Operations Research Conference Proceedings, Society for the Advancement of Management, September 29-30, 1955.

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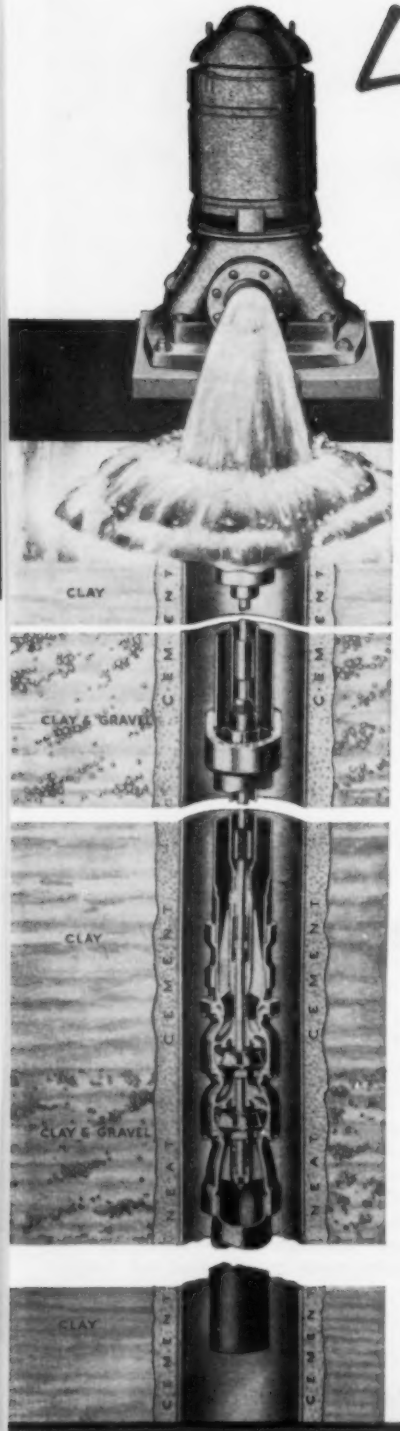

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Italy sinks in morass of nationalized oil industry . . . Needed foreign capital is fenced out by one-sided legislation whooped up by Communists and Socialists

Wallace A. Sawdon

TO say that the new oil law (Hydrocarbons Bill) passed by the Italian Senate in December 1956 has caused concern to private enterpise, both national and foreign, is the understatement of several decades. Immediately upon its passage the Gulf interests withdrew entirely from all exploratory operations on the mainland of Italy, and it is reasonably certain that other foreign operators will do the same.

What the privately owned Italian companies will do is a question; but they certainly are not happy with the situation. It is also probable that the Senate itself is not happy, because the new law does not do what it was intended to do, or at least not what it was previously claimed to have intended to do.

It must first be emphasized, however, that the Italian law does not apply to Sicily where the Regional Law of 1950, which has proved equitable to both the Sicilians and all the private enterprise companies, both Italian and foreign, is in effect.

For instance Gulf Italia operations on the Ragusa concession began in 1954 with a production of 48 bbl per day and was producing at a rate of over 19,000 bbl per day by the first of February 1957. At the latter date there were 14 producing wells, 4 exploratory wells and 2 development wells drilling.

A 75-kilometer, 14-in. pipeline, completed January 28, 1957, carries crude from Ragusa to Augusta and Panisola Magnisi with a total capacity of 38,356 bbl per day, or 2,000,000 tons a year, about twice the amount being currently produced.

Other companies are active in Sicily. Among these are the Augusta Richerche Petrolifere, jointly owned by a Jersey Standard subsidiary and Raffineria Siciliana Olii Minerali, which has discovered some gas near Mt. Etna; Sinia Viscosa, an Italian firm, which has drilled in central Sicily; Mediterranean Oil Company, a Gulf and MacMillan corporation which has drilled near Ragusa; and Azienda Generale Italiana Petroli (AGIP), the producing subsidiary of Ente Nazionale Idrocarburi (ENI), the tax-free Italian national corporation, which also has discovered some gas in eastern Sicily.

On Mainland It's Different

Italy needs all the oil that can be recovered within its boundaries — and needs it badly. In September 1955 it was estimated (by the government) that at that time Italy was spending approximately 200 billion lire ($320,000,000) for oil imports per year. With the increased industrial and other growth of the country this will probably be more than doubled by 1960 if substantial production is not acquired.

But with the new oil law scaring off foreign risk capital and experienced know-how, and making it most difficult for even small national free enterprise companies to operate, there is little chance of offsetting much of the imports that are necessary for the development of the country. Yet the Italian people think there are great reservoirs of oil in their country that will be tapped under the guidance of a benevolent government — while they keep on paying 75 cents a gallon for gasoline.

What is this oil law of 1956? There are many angles to it but first consider the remuneration. The royalty ranges form 2.5 percent for a well making up to 4 tons per day, to 22 percent on production in excess of 256 tons per well per day. For natural gas, the same rates apply, based on one ton of oil being equivalent to 1200 cu m of gas. Then there are direct and hidden taxes that result in a final percentage to the Italian Government that has been almost universally estimated as bringing the total to at least 60 percent of the net profit. This in itself will keep out foreign risk capital and break the 50-50 limitation maintaining in all other countries.

But that is not all. In other countries where a 50-50 net profit basis obtains, the companies are permitted to do their developing work freely without land rentals and are allowed to recover their investment. Under the Italian law, however, the company pays rentals and starts paying royalty and taxes to the full amount as soon as oil is produced.

Moreover, the companies operating in other countries are reasonably certain of substantial reserves for many years in the future, while in Italy there are no known reserves, even in the most promising area, the Po Valley — and ENI has it tied up.

Exploration Expensive

The conditions are thus entirely different in Italy. It does not have a history of production behind it and exploratory work is entirely speculative and expensive. Moreover, a company, whether it be national or foreign, must drill on a permit and then after discovery hope to get a concession for production. This is subject to onerous forfeit clauses and, when wells are pro-

Mr. Sawdon is a well-known petroleum writer; was once on the editorial staff of *The Petroleum Engineer*. At present he is Executive Secretary of Los Angeles Chapter of Nomads.

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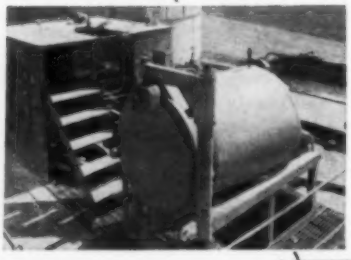

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ducing, they must be produced to the amount per day that the inexperienced government bureaucracy specifies.

In spite of all this, private enterprise companies were previously willing to take a chance until the 1956 law was passed because there has been minor production and there exist indications that there are possibilities of developing oil on the mainland in amounts that would be attractive to the investor.

For example, Gulf Italia owned a half interest with Montecatini S.p.A. in Petrosud, S.p.A. which discovered oil at Cigno near Piscara in the Adriatic province of Abruzzi early in 1955. This was near a dry hole drilled by AGIP, the producing subsidiary of ENI.

Upon discovery by Petrosud, AGIP returned to the field and Petrosud was forced to shut-in its two producing wells while AGIP was getting back into business in that area. It was later allowed to produce again on a restricted basis. Gulf Italia has now arranged with Montecatini S.p.A. to dispose of its participations in Petrosud and in other areas of the Italian mainland.

IPEX Tries

Now consider the smaller foreign operator. Italia Petroleum Explorations (IPEX) is a good example. This is a California limited partnership of which William Thornbury and W. H. Geis of Los Angeles are the general partners with D. B. Grable as manager in Rome. Ipex entered into an exploratory campaign on a confirmed oil and gas concession, the terms of which had been fixed under the previous Italian oil and gas law. After extensive geological and geophysical surveys Ipex proceeded to drill a deep well which seemingly developed production possibilities.

When the well was drilling, the 1956 law was passed and completely changed the terms of the concession. Annual rental increased nearly 300 percent and royalty increased 700 percent. At the same time size and configuration of the concession were changed together with the operating provisions.

Under the terms of the new law there was nothing that Ipex could economically do but shut-down exploration and seek release from its obligations, which had been originally undertaken in good faith under a contract with the government on an existing concession. This has been done, but results prove, as Don Grable expressed it, that "the law lends itself to the use of private risk capital and private know-how to create a more powerful state-owned company."

Which now brings up the subject of ENI and what the present law does for it. Previous to its enactment last December, ENI, the tax-free government agency, was granted a virtual monop-

oly over almost all the possible productive area of the Po Valley, an area of approximately 18,000 sq miles. This is the most promising area for oil production now known in all Italy, although little but gas has been produced to date. ENI's operations appear to be somewhat less than efficient, but the new law maintains this monopoly.

Enrico Mattei, who runs ENI and appears to have a strangle hold on everything petroliferous in Italy, was the prime mover in getting the oil law passed. He evidently had little trouble getting it through the Chamber of Deputies but did have some difficulty in forcing the Senate to pass it. Several amendments were proposed, but he knocked them down.

In the Chamber of Deputies, the Communists and Socialists overwhelmingly supported the bill and it looks as if they have practically nationalized the oil industry and have almost legislated private enterprise out of Italy. While this seemingly applies to the oil industry alone, it shows a trend in other industries.

In talking to some industrialists on the train from Nice to Rome, the author got a gloomy picture of the future. One, who was a Sicilian, emphasized, however, that his remarks did not apply to Sicily. There is no question that Mattei has political power, without yet being actually in politics. He is a close friend of the president.

Aside from direct financial consideration with the 60-40 ratio which no foreign operator could consider since it would certainly be an opening wedge on which other countries could cast a speculative eye, the oil law of 1956 has other oppressive aspects.

When a company gets a permit for exploratory drilling, this does not mean it will get a productive concession if it strikes oil. At the moment, it possibly would. But how about the future? The concession is granted by the Minister of Industry and Trade after having consulted with the Technical Committee on Hydrocarbons, which was set up in the new law. The terms of the concession are entirely at the government's discretion. The company has little, if any, legal protection, and future policy may eliminate any semblance of protection.

Maximum size of exploration permits is definitely set down for free enterprise companies; but not for ENI. Any one permit may not exceed 50,000 hectares* and the total permit area allowed to one company in the whole of the Italian mainland is limited to 300,000 hectares. When oil is discovered, however, the production concession is cut down to a maximum of 3000 hectares and the total production

*One hectare equals 2.471 acres.

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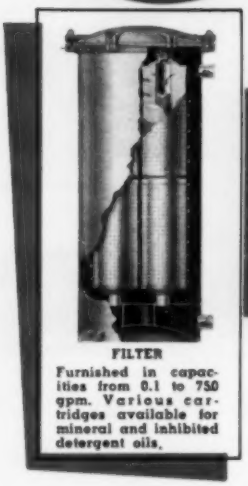

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concessions throughout the country cannot exceed 80,000 hectares. Again, the production maximums do not apply to ENI.

But the most frustrating item is that a one-kilometer continuous corridor adjacent to the perimeter of the concession area is reserved to the State. Width of this corridor is proportionally reduced in cases where the concession area is less than 3000 hectares, but never less than 500 meters. These areas reserved to the State may be auctioned to Italian nationals or corporations with head offices in Italy with a base auction price determined by the Minister of Industry and Trade in agreement with the Technical Committee, the amount not to be less than 5,000,000 lire. The ENI is excluded from such auctions — *but* — in the event there are no bids tendered, the base auction price may be reduced or the concession may be granted to ENI. Knowing the political influence of Mattei, it can be assumed that ENI will turn up with concessions on the best, if not all, the corridors.

Free Information

Furthermore, anyone drilling on a permit must inform the Mining Authorities on the geological and geophysical surveys carried out as well as submit in advance the program relative to the drilling method used for each well and supply information on the progress of operations and results thereof. He must notify the Mining Authorities of any discovery within 15 days; must supply all technical and financial data and any information requested by the authorities; must store samples of solid, liquid and gaseous material taken during operations, as well as samples of the minerals found; and must deliver to the Mining Authorities samples requested by them.

ENI can thus get all the data relative to an area at the operating company's expense and can use it in the corridor surrounding the production concession if it is granted a concession on the corridor. Also, during production of a concession, the operator must continue to supply technical and financial data and other information requested by the Mining Authorities.

The new oil law is of the State, by the State and for the State. Some few national free enterprise companies may get a few crumbs; but not if the crumbs are too big. The law will take care of that.

Just at the time when Italy needs all the oil it can get from its own mainland reservoirs, which are still unproved, it passes a law that keeps out the capital and know-how, which the international free enterprise companies could supply. ★ ★ ★

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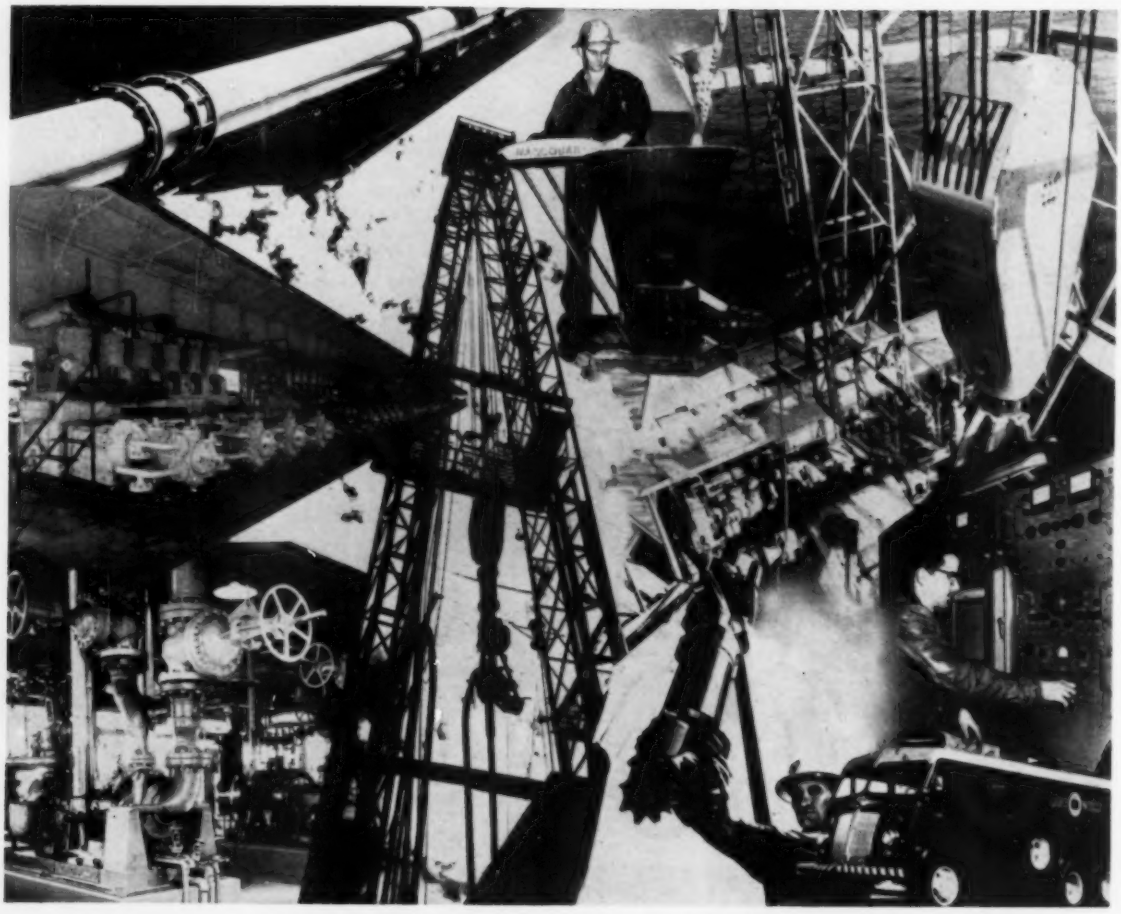

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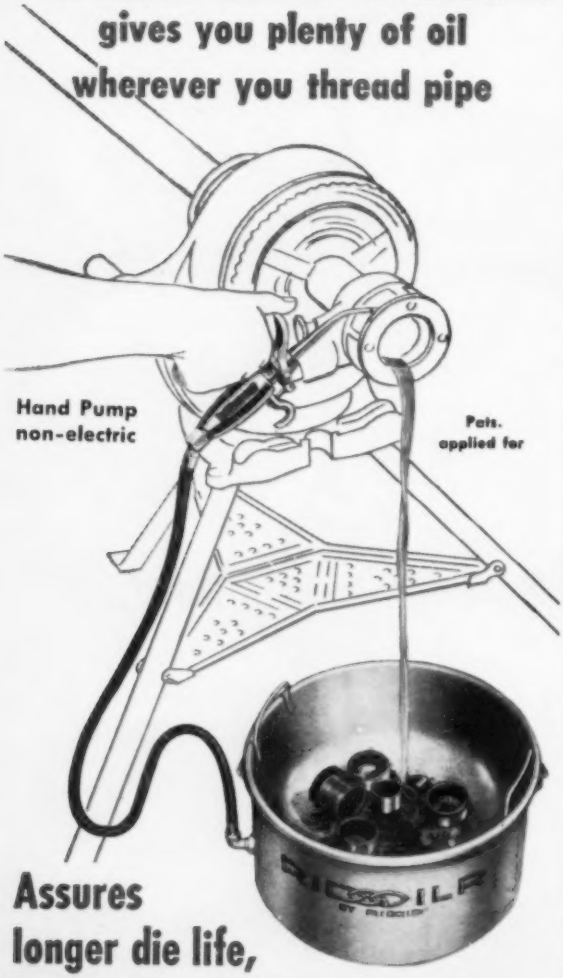

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The second book in the University of California engineering extension series, it is written by 19 outstanding men in the applied mathematics field. Following the mathematicians technique of writing solutions in generalized equations, the content forms an excellent guide to the engineer interested in the application of advanced mathematics to technical problems. Well written for the engineer, it covers classic vibration applications through high speed computation procedures which have been introduced in recent years.

Pilot Plants, Models, and Scale-up Methods in Chemical Engineering, *by Robert E. Johnstone and Meredith W. Thring, published by McGraw-Hill Book Company, 330 West 42nd Street, New York 36, New York. Pages, 307. Price, $9.50.*

This book presents an analytical and quantitative approach to the several ways in which model theory and its empirical extensions can be used in pilot plant and model design along with interpretation and scale-up of results. Initial chapters are devoted to concepts, the later chapters, application in design of unit operations equipment. Only drawback is that there are too few examples that fully illustrate application of principles.

Gas Chromotography, *by A.I.M. Keulemans, edited by C. G. Verver, published by Reinhold Publishing Corporation, 430 Park Avenue, New York 22, New York. Pages, 217. Price, $7.50.*

An exhaustive manual on theory and operations for gas chromotography, designed for the petroleum industry and others manufacturing hydrocarbons. Discussion includes methods, applications, apparatus, theory, adsorbents, etc. Numerous illustrations and charts contribute heavily to making the text of value to both the practical and theoretical chemist as an aid in setting up equipment, and making quantitative and qualitative hydrocarbon identifications.

Project Engineering of Process Plants, *by Howard F. Rase and M. H. Barrow, published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, New York. Pages, 692. Price, $14.25.*

This extremely practical book will be of value not only to project engineers, but also to any engineer that must have knowledge of the theories and techniques of mechanical design, procurement, and construction. Chapters include discussion on the major steps in plant design, business and legal procedures, engineering design and equipment selection (about two-thirds of the text), and plant construction. Extensive references add markedly to the book's utility.

Chemical Materials Catalog, *published by Reinhold Publishing Corporation, 430 Park Avenue, New York 22, New York. Pages, 537.*

The 1956-57 edition is the eighth in this series. It provides detailed chemical and raw materials data from more than 130 companies. Indexes and sections include a directory of producers, product index, applications index, and trade names. Recommended for those engaged in organic and inorganic chemical manufacture.

The Demand and Supply of Scientific Personnel, *by David M. Blank and George J. Stigler. National Bureau of Economic Research, 261 Madison Avenue, New York 16, New York. Pages, 200. Price $4.*

How serious the scarcity of engineering personnel is in the United States is a question to which no confident answer can as yet be given, according to a report by David M. Blank and George J. Stigler, just released. The popular notion of a severe shortage of engineers loses some of its validity when the available economic facts are examined and their limitations understood, the authors say. The statistics they report, and their suggestions for developing basic information now lacking, may give small comfort to the tireless recruiter of engineers so familiar on college campuses today, but do offer long-run practical guidance to business managers, educators, and government planners.

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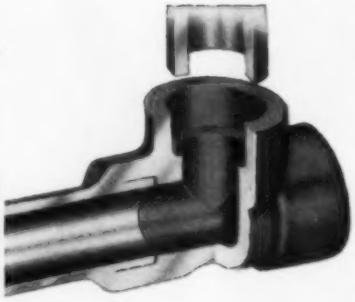

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Laugh With BARNEY

They tell the one about the landlord who, asked why he didn't light up his dark hallway, replied: "We had a light there for three years. No one fell, so we took it away."

A landman was driving through a West Texas county and had the misfortune to knock down a calf which was crossing the road. He stopped at a nearby farmhouse and reported the accident to the farmer who owned the animal and asked how much the calf was worth. "Well," said the farmer slowly, "It's worth about $35 now, but in six years, it would have been worth about $250.

The landman took out his checkbook, sat down at a nearby table and wrote rapidly. Tearing a check out of the book, he handed it to the farmer.

"There you are," he smiled. "There's a postdated check for $250."

Man blames Fate for other accidents but feels personally responsible when he makes a hole-in-one.

Throat specialists say that smoking makes women's voices harsh. If you don't believe it, try flicking your cigarette ashes on the rug.

There had been severe floods in the valley and the sanitation officer hurried to the scene.

He queried one old couple. "The water supply may be polluted. What measures are you taking here?"

The old chap answered, "First we boil the water. Then we filter it. Then we drink beer."

The ladies were playing bridge one afternoon and the lady sitting to Mrs. Jones' left reached over and tapped her on the arm.

"Mrs. Jones, do you know your husband is running around with his secretary?" Mrs. Jones kept right on studying her cards.

"Mrs. Jones," the woman insisted, "did you know your husband is running around with another woman?" Mrs. Jones finally looked up with a frown.

"Yes, I know he's dating his secretary, now stop interrupting."

"But Mrs. Jones, aren't you concerned about it?"

"Look Mrs. Brown, I'm not worried about it, why should you? It's like our old dog Rover who chases cars. If he caught one he couldn't drive it."

The latest gimmick being sold door to door is for old ladies that have small dogs. It's called the "Super Duper Do Do Scooper."

Miss Rose Boscia of the Bronx, New York, sent in "A Definition of Marriage: It can be either a tender trap or a mouse trap."

To liven up Barney, W. E. Hannon of Drumright, Oklahoma, sent this poem:

Said Billy Rose to Sally Rand
Why don't you dance without your fan,
So, Sally danced without her fan
Billy rose and Sally ran.

PAPER WEIGHT

. . . the heaviest thing on an engineer's mind

Vince Gates

YOU can't build a bridge with paper, of course, but engineers aren't so sure about a dam — the tons of paper that pile up on today's plans and projects are enough to build a breakwater in the biggest bay.

An engineer the other day offered to start a "PC Club" — dedicated to one objective: "Paper control." He would require only simple membership rules: A clean desk and a full waste basket.

Paper control today is occupying the attention of management. An eastern corporation in 1949 inaugurated a new series of records, neatly filed away in cabinets, indexed and cross indexed. In four years it became a Frankenstein, eating up valuable space like a monster.

Then the firm literally took the file cabinets by the horns (or handles) and systematically discarded everything except current work records. It gave the clean-out crew a slogan: "If we don't use it, lose it." Savings of $68,000 resulted — plus some efficiency planning from there on.

Business firms aren't alone in their new-found realization that paper can wad up the gears of industry. U. S. Government-stored records cost $40,000,000 annually, occupy space equivalent to four Pentagons. The paper tidal wave created by this surging maelstrom of memos is produced by enough clerks to fill 36 Empire State buildings.

A Hoover Commission task force under Emmett Leahy, a record management specialist, reveals that useless paperwork annually costs the U. S. a sum equal to the entire Federal budget of a half century ago.

Business has taken a cue from Uncle Sam, is subjecting itself to examination. One firm that advertised its products would "reach around the world" also found its paperwork did too — twice around. Another discovered it was paying more money for file storage than for product warehousing. Remington Rand warns that it costs more than $7700 to create the contents of a five-drawer company file — plus $231 a year to maintain it.

Records Management Associations are setting up strict record control procedures. Essential records are often microfilmed; copies of routine letters, reports and other documents are routed to interested parties, then marked for discard. Only occasionally is a historical copy kept.

The calculated risk in destroying important records and correspondence is small, considered to be worth the big savings of money, time, effort — and space — resulting from Paper Control. Success has simplified filing procedures, cut down office expense. Purchases of new filing cabinets frequently drop twelvefold — and waste paper sales boom.

One management man, after house cleaning his office in a "paper-profits" program, tacked a sign on his desk with an arrow pointing to the wastebasket.

"The circular file is the most important file in this office," the sign read.

* * *

Mr. Gates is editor of *Kaiser Builder*, publication of Kaiser Engineers Division of Henry J. Kaiser Company, Oakland, California, from which this article is taken.

Oil execs agree: if it's fast delivery you want, you want Worthington QD (Quick Detachable) sheaves—the original two-piece design. MV-7.1

WORTHINGTON CORPORATION, Oil City, Pennsylvania

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Now Standard refines a rare "rock" to give U.S. a new source of gasoline

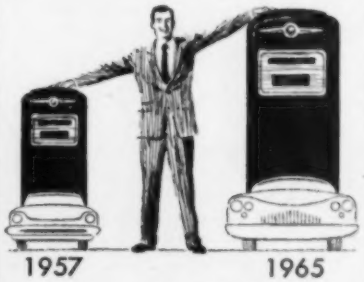
High pressure water jet shatters solid Gilsonite. Flume hose washes particles down mine floor to pipeline.

Petroleum products are now being made without crude oil. Standard found the answer in a rare hydrocarbon called Gilsonite. But it took $16,000,000 and a vast research program to do it. Deep in the mountains of Utah our scientists worked out a better, faster way to mine Gilsonite. Meanwhile our engineers designed the nation's first pipeline capable of carrying solids suspended in water . . . over rugged terrain to a spot 72 miles away.

There Standard* built the nation's first privately financed refinery to make petroleum products from a material other than crude oil. Today that refinery turns Gilsonite into high octane gasoline for motorists, and the purest coke known for making steel, aluminum and other metals. In our country's search for new sources of fuel, the development of Gilsonite is a major breakthrough. It means the equivalent of 100,000,000 barrels of oil added to U.S. underground reserves—important help in meeting our country's growing petroleum needs.

Progress in the West means...

New sources of gasoline to fuel 5½ million more motor vehicles by 1965†



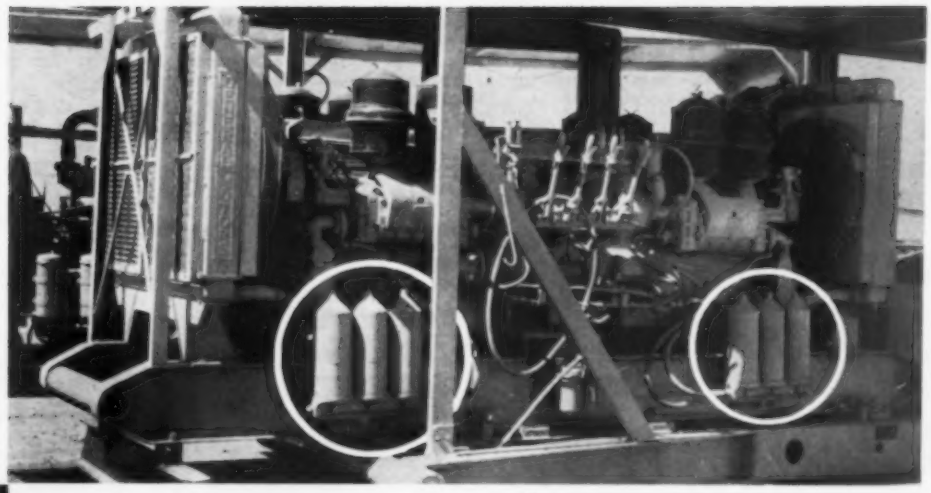
†In 11 Western States

STANDARD OIL COMPANY OF CALIFORNIA

plans ahead to serve you better

**Through American Gilsonite Company, a Standard affiliate*

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD



WINSLOW *Full-Flow* **FILTERS**

Case History Report No. 37 Shows Why Engines Protected by WINSLOW FILTERS Last Longer

LUBE OIL KEPT CLEAN A MONTH INSTEAD OF A WEEK *with Winslow CP* Filters*

Laughlin & Porter Co. of Odessa, Texas, one of the largest Texas oil drilling companies, operates many drill rigs. Power for some electric generators is supplied by a quad installation of four 6-71 GM engines. The engines run 24 hours a day—a real tough test on lube oil—on filters and on engines.

With original filter equipment, oil and element changes were made every week. Since the installation of WINSLOW B-74 Full-Flow Filters, with CP* elements, oil and elements are changed only once a month or after 720 operating hours.

That's important in operating costs, and other big savings are longer engine life and lower maintenance cost, with the use of Winslow Filters. Ask about the application of modern CP* filters for all your powered equipment.

CP* FILTRATION

Winslow patented CP* (Controlled Pressure) elements are designed to continuously self-adjust the pressure within the filter and allow for a full stream of filtered oil without opening by-pass valves. This is accomplished through the dual flow capacity, with two types of material in the same element.

**CP is fully protected by patents and trademarks*

WINSLOW ENGINEERING & MANUFACTURING COMPANY

4069 Hollis Street, Oakland, California

W-2593-A

Management Personals

Frank X. Jordan, former programming specialist in the Interior Department's Office of Oil and Gas, has been added to the staff of the Independent Petroleum Association of America in Washington. He joined the National petroleum organization as petroleum analyst. He worked with Phillips Petroleum Company to receive his industry experience.

F. X. Jordan

Rear Admiral H. B. Miller, USN (Ret.), has resigned from the American Petroleum Institute to assume the duties of director of public relations of Pan American World Airways. **Philip C. Humphrey** was designated as acting director of the department of information of the American Petroleum Institute and Acting Executive Director of the Oil Information Committee.

J. O. DeLancey was appointed secretary treasurer of The California Oil Company. In his new position DeLancey replaces **F. W. Mayer** who has retired. DeLancey was formerly manager, personnel and labor relations.

Hubert H. Raborn was elected secretary and treasurer of Kerr-McGee Oil Industries, Inc., Oklahoma City. He has been vice president and secretary of Triangle Refineries, Inc., of Houston, Texas, an operating subsidiary. Raborn will continue in his position with Triangle.

Three men will serve as assistant secretaries and assistant treasurers of Kerr-McGee: **S. B. Robinson,** who has served as assistant secretary and assistant treasurer of the company since 1951; **W. O. Holdren,** formerly assistant secretary and assistant treasurer of the Deep Rock Oil Company, a subsidiary absorbed by Kerr-McGee in May 1956, and **J. H. Lollar Jr.,** formerly secretary and treasurer of Kerr-McGee and treasurer of Triangle Refineries, Inc.

E. Clyde Seymour was named senior vice president of Magnolia Petroleum Company. **Robert M. Chan,** now first vice president of Magnolia, retired after 22 years with the account and finance policies of the company.

E. C. Seymour

R. M. Chan

Julius Aronofksy, research associate at Magnolia Petroleum Company's field research laboratory near Dallas, has transferred to Socony Mobil Oil Company, Inc., as manager of the electronic computer center in New York City. **Lucien Masse** will replace Aronofsky as leader of the applied mathematics group at Magnolia's field research laboratory.

A. P. Frame, vice president and director of Cities Service Company was elected a director of the Coordinating Research Council, Inc. He also is president and director of Cities Services Research and Development Company, as well as vice president and director of Cit-Con Oil Corporation, Petroleum Chemicals, Inc., and Mid-South Chemical Company.

Milo M. Brisco was elected executive vice president of International Petroleum Company, Ltd. He was elected to the board of directors of International at the annual meeting of the shareholders held in Toronto last May.

Kerryn King was named general manager of the industrial and public relations department of The Texas Company. He was formerly assistant general manager and director of public relations. He will be succeeded as director of public relations by **Thomas D. Durrance,** who has been supervisor of editorial services. **Robert T. Kenney** and **Thomas F. Brawner** were named assistants to the director of public relations with headquarters in Los Angeles and Houston, respectively.

Kenyon Zimmerman, former safety engineer for the Ohio Oil Company's supply and transportation organization, was appointed supervisor of the safety department. Zimmerman succeeds **H. C. Walker,** acting safety supervisor, who will continue as assistant manager of Ohio Oil's personnel division.

WHEELING
COUPLINGS
FOR OIL COUNTRY USE
LINE PIPE COUPLINGS A.P.I.
⅛" to 12" — Seamless — Black or Galvanized
PLAIN TUBING COUPLINGS A.P.I.
1" to 4" — Seamless
EXTERNAL UPSET TUBING COUPLINGS A.P.I.
¾" to 3½" — Seamless
CASING COUPLINGS A.P.I.
4¼" to 13⅜" — Seamless — Long or Short
HYDRAULIC COUPLINGS
⅛" to 4" — Seamless
REAMED AND DRIFTED A.I.S.I.
¾" to 12" — Seamless
DRIVE PIPE COUPLINGS
6" to 12" — Seamless
TOP QUALITY Since 1918
Sales Offices in Leading Cities:
Albany, N. Y.—Albert L. Becker, 434 Clinton Ave.
Baltimore, Md.—James W. Fankhanel, 2301 No. Charles St.
Chicago, Ill.—Harry A. Jay, Suite 1090, Old Colony Bldg.
Denver, Colo.—Earl H. Jones & Co., 1863 Wazee St.
Detroit, Mich.—R. W. Lang, Jr., 505 Park Avenue
Erie, Pa.—R. J. Maggi, Box 711
Falmouth, Mass.—Walter S. Bennett, 53 Minot St.
Grand Rapids, Mich.—R. W. Lang, Jr., 138 Burton SE
Houston, Texas—Henry H. Paris Distributor, Inc., Box 932
Independence, Mo.—Craig A. Fross, 3701 Norwood
Los Angeles, Cal.—James A. Riordan Co., 1400 Santa Fe Avenue
Louisville, Ky.—Sid. Schultze Co., 514 W. Main St.
Milwaukee, Wis.—W. G. Nelson, 3347 N. 97th St.
Narberth, Pa.—J. W. Worthington, 105 Forrest Ave.
Newark, N. J.—Ira L. Rothenberg & Assocs., 398 Market St.
New York, N. Y.—Max Rothenberg, 11-05 38th Ave., Long Island City
Omaha, Neb.—Wm. Freiden, Central States Engineering & Sales Co., 5101 Blondo St.
Oswego, N. Y.—Northeastern Associates, Inc., Neil Chatterton, Secretary, P. O. Box 284
Portland, Ore.—Earl H. Jones & Co., 1233 NW 12th Ave.
Richmond, Va.—P. C. Abbott & Co., 15 E. Franklin St.
St. Louis, Mo.—Walter C. Dollinger Co., 4869 Goodfellow St.
Seattle, Wash.—Earl H. Jones & Co., 819 Thomas St.
WHEELING MACHINE PRODUCTS COMPANY
WHEELING, WEST VIRGINIA
Factories at WHEELING, W. VA. and WOODLAKE, CALIFORNIA

Personals

W. R. Huber, director of public relations for Gulf Oil Corporation, Pittsburgh, Pennsylvania, was named director of the petroleum industry's Centennial celebration in 1959 for the American Petroleum Institute.

O. F. Van Beveren was elected vice president and director of Standard Oil Company of California, Western Operations, Inc., and named general manager of the company's exploration department.

John G. Belcher was appointed an assistant comptroller of International Petroleum Company, Ltd., in Coral Gables, Florida. Belcher held until recently the position of coordinator of producing and refining accounting in the comptroller's department of Esso Export Corporation.

Winston S. Peeler was elected vice president in charge of manufacturing and a member of the board of directors of

W. S. Peeler

W. T. Herget

American Oil Company. Peeler, who succeeds the late Dr. Harold R. Snow, had served as general manager of manufacturing since last February when he moved here from Texas City, Texas. **Walter T. Herget** has been named to succeed Peeler as general manager of manufacturing.

R. D. Stetson and **A. F. Smith,** two senior Shell Oil Company executives, were honored for their long company service with a luncheon at the California Club. Stetson who marked his 35th year with Shell, is manager of the Los Angeles marketing division. Smith, who has completed his 24th year, is manager of West Coast personnel and industrial relations.

Dr. Paul Darwin Foote, retired vice president of Gulf Oil Corporation and physicist, has been selected by President Eisenhower to head missile and other scientific programs in the Pentagon.

H. E. Snow and **M. R. Bridgeman** were elected deputy chairmen by the board of The British Petroleum Company, Ltd.

Eleanor C. Dickson was elected secretary of Standard-Vacuum Oil Company, the first woman to be elected to this office. She was formerly assistant secretary.

Garvin H. Dyer, director of the Missouri Water Company and manager and chief engineer of the Independence Division of the firm, was elected president of the National Society of Professional Engineers. He succeeds **Robert J. Rhinehart** of Pine Bluff, Arkansas. New vice presidents are: **A. H. Kidder,** Philadelphia, northeastern region; **John B. McGaughy,** Norfolk, Virginia, southeastern region; **Harry G. Kennedy,** Charleston, West Virginia, central region; **W. L. Hindermann,** St. Paul, Minnesota, north central region; **Clark A. Dunn,** Stillwater, Oklahoma, southwestern region, and **L. R. Durkee,** Seattle, Washington, western region. **Russell B. Allen,** College Park, Maryland, was elected for his tenth term as treasurer.

DEATHS

Dr. Dennis L. Murphy, 55, Service Pipe Line Company administrative assistant and former University of Tulsa professor, suffered a fatal heart attack September 9. He was stricken in a Boston hotel where he had gone to address a New England Gas Association convention. He was author of the communications series published in The Petroleum Engineer.

D. Glenn Morgan, 67, retired director of research and development for D-X Sunray Oil Company, died September 11 of a heart attack in Chicago.

Colonel George A. Burrell, chairman of the board of Burrell Corporation, died August 16 after a long illness.

George Granger Brown, 60, dean of The University of Michigan College of Engineering, died August 26. He was well known in the fields of combustion and fractional distillation, as a consultant and research director. He had been writing articles for The Petroleum Engineer since 1930.

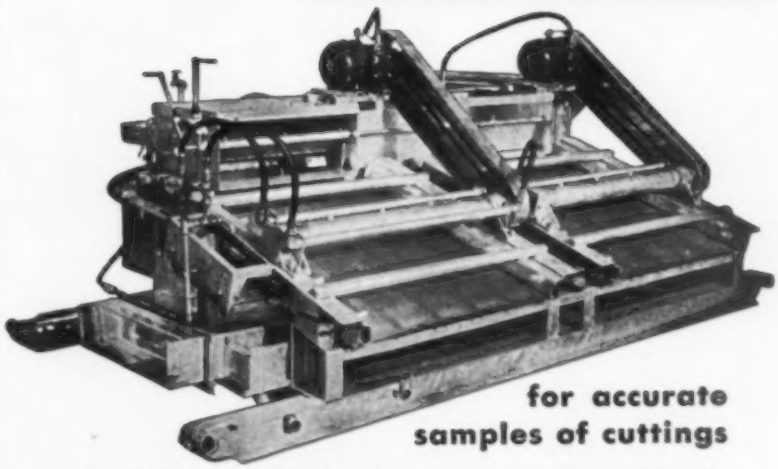
John R. McConnell, 69, former vice president and director of advertising of American Air Filter Company, died August 8 following a short illness.

J. P. Troll, 77, retired independent oil producer, died July 28 following an illness of about 8 years.

Joseph W. Moorman, 46, a consulting engineer to the petroleum industry and University of Tulsa instructor, died July 27 after a weeks' illness.

Thompson

DOUBLE VIBRATING SHALE SHAKER...and SAMPLE MACHINE



for accurate samples of cuttings

The THOMPSON SHALE SHAKER SAMPLE MACHINE offers the operator and geologist one of the best methods available for obtaining accurate foot-by-foot samples of well cuttings.

This THOMPSON DOUBLE VIBRATING SHALE SHAKER and SAMPLE MACHINE is specially engineered for off-shore barges or islands, deep wells, or wells using big volume and high pressure mud pumps. It is available either plain or galvanized, which makes it rust and deterioration-proof on off-shore or coastal duty

THOMPSON Shakers are famous for their highly efficient service at any depth or flow and for their economical first cost.

Make sure THOMPSON'S on the job for accurate samples and clean mud.

SOLD ONLY THROUGH SUPPLY STORES

Thompson TOOL CO. IOWA PARK TEXAS

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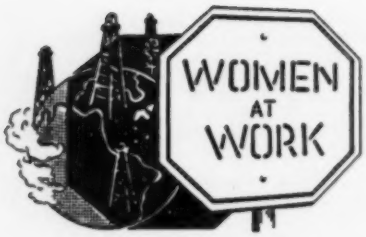


All-Women Company

The most feminine oil producing firm in an industry that is masculine is the Little Nick Oil Company, Chickasha, Oklahoma. Little Nick is owned by a woman, its offices are staffed entirely by women, and, even though it's hard to believe, run by a woman — Jessie Dearing. When she became an oil producer by chance 13 years ago, she didn't even know what made a drilling rig work.

Chickasha is the home of Oklahoma College for Women, which Jessie entered to become a teacher. During the summer before her last year in college, (which was during the depression) she needed money badly. The Nichlos family (owners of Little Nick Oil Company) was looking for a housekeeper and Jessie got the job. They became good friends and when she returned to college she was assured a job would be awaiting her with Little Nick upon her graduation. After John B. Nichlos' death Mrs. Nichlos turned to Jessie to keep the company going.

Sometimes her willingness to take a long chance startled the oilmen of the area who had been in business longer.

Once, Jessie decided that the future of the Chickasha gas field lay in exploring deeper formations. The cost of such a project was tremendous. Could Little Nick drill to 8500 ft, when they had never drilled below 6000 ft and didn't have a rig that could go down 7500 ft. At 8500 ft she saw no reason to stop, but at 15,800 she finally called a halt. Although Little Nick got only small gas production from the drilling, they got a lot of information.

Jessie had a lot to learn and did. Now her eyes sparkle as she tells some of her stories of the oil industry.

D & D Awards

Encouraging a high level of attendance, good communications through the medium of club bulletins, and maintaining a history of achievement, the Association of Desk and Derrick Clubs of North America held the third series of contests during the Sixth Annual Convention.

Mrs. Edna Hurry, New York City, contest coordinator, announced the attendance contest winners; Membership of 1 to 50 members, Great Falls, Montana; 51 to 100 members, Bartlesville, Oklahoma; 101 and over, Dallas.

Mrs. Nora Cunningham, Duncan, Oklahoma, bulletin contest chairman, presented certificates of awards to:

Best all around bulletin: First, Mrs. Louise I. Brown, editor "The Producer," Ardmore, Oklahoma, and runner-up, Betty Sampson and Betty Jean Miller, editors "The Gusher," San Antonio, Texas.

Best art: First, Mrs. Pat Tankersley, staff artist for "Black Magic," Duncan, and runner-up, Miss Sampson.

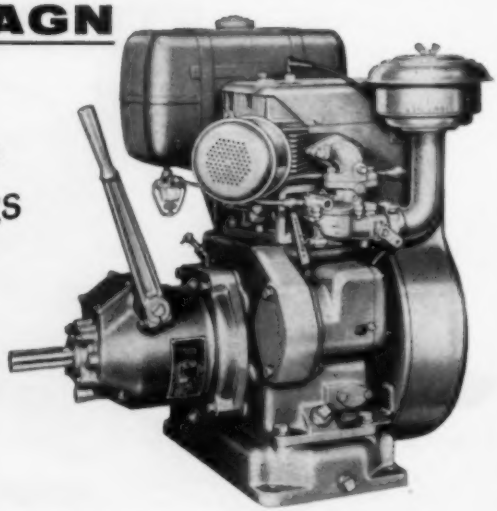
News Reporting: First, Mrs. Mary Jo Rustamier, for story from combined reports of Midland, Texas, club members Ervie Hays, Loreitta Hall, Reba Hawthorne, Lulu Belle Klingler, Dorothy Herzer, and Ila Tusbury; runner-up, Maurine K. McLaughlin, Duncan.

Best editorial: First, Lucille McKinney, Jackson, Mississippi, and runner-up, Mrs. LaVerne Montgomery, Lubbock, Texas.

Best Feature Story: First, Mrs. Nora Cunningham, Duncan, and runner-up, Mrs. Virginia Dupies, Dallas.

Miss Fae Matson, Fort Worth, scrapbook committee chairman, awarded certificates to: First, Houston, Texas, Jerry Benge is historian. Second, New York, Editor is Dorothy Sammis.

A NEW, BIG, 4-Cycle
Single Cylinder Air-Cooled Engine...
the WISCONSIN 12½ hp.
MODEL AGN
by Engine Specialists



Model AGN Engine with Clutch Assembly. Also available with stub shaft or with Reduction, Clutch Reduction and/or Electric Starting

• It takes full-time engine "know-how" and full-scale engine manufacturing *concentration* to design and produce engines of outstanding character *and* Performance Ability.

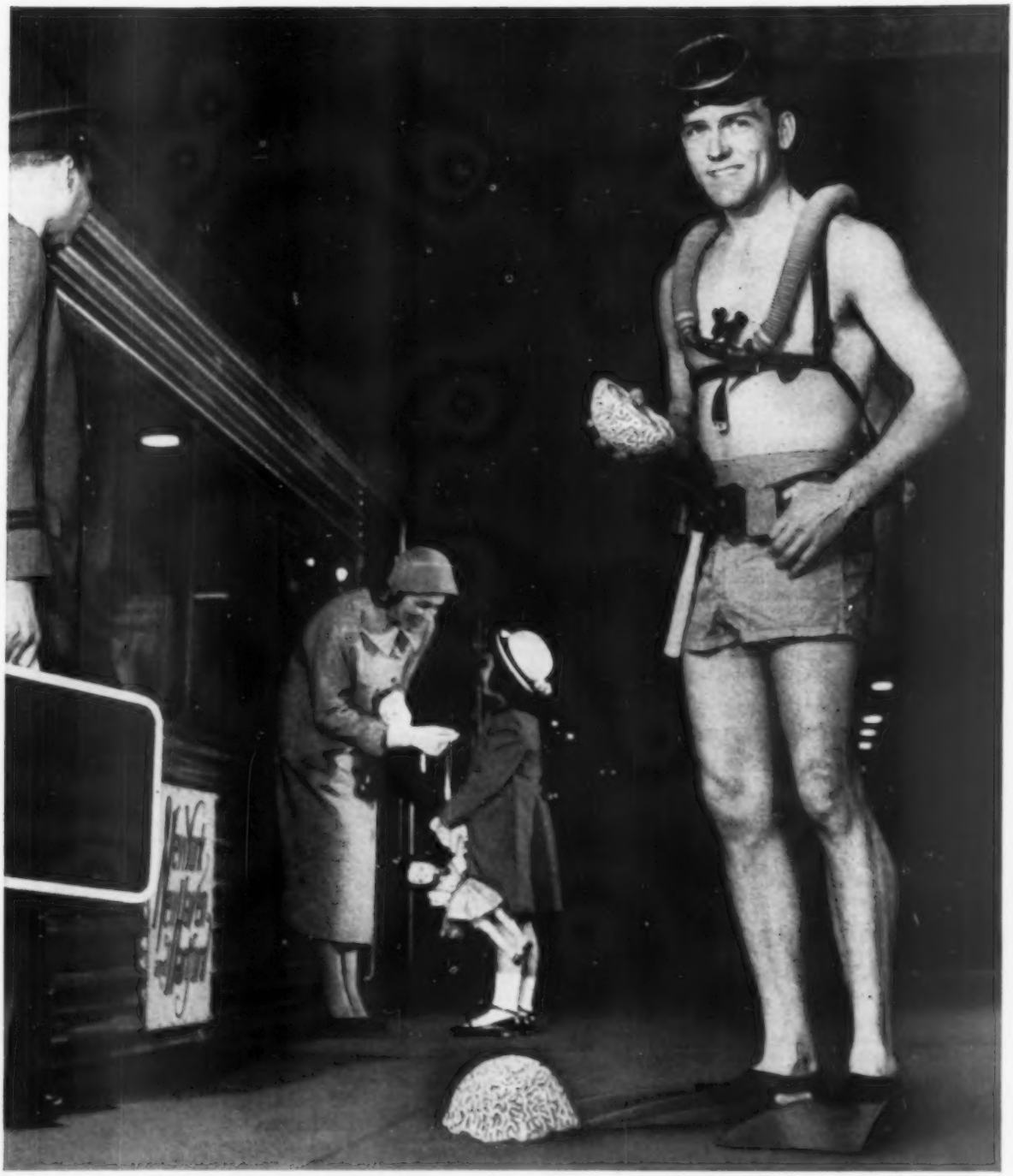
The new Wisconsin Model AGN 12½ hp. engine is the product of this unbeatable combination. *Engine specialists designed it. Engine specialists are building it.*

Putting 12½ hp. into a single cylinder air-cooled engine calls for basic *High Torque* . . . the *load-holding Lugging Power* that keeps the equipment *working* through sudden shock loads. It also calls for heavy-duty construction in all details . . . plus dependable cooling under all weather conditions from sub-zero to 140° F.

Bulletin S-216, just off the press, will give you details about Model AGN. Write for it.

WISCONSIN MOTOR Corporation
MILWAUKEE 46, WISCONSIN
World's Largest Builders of Heavy-Duty Air-Cooled Engines

WRITE TO HARLEY SALES CO.
619 SOUTH MAIN STREET • TULSA, OKLAHOMA
2420 McKINNEY AVENUE • HOUSTON, TEXAS
303 SOUTH MAIN STREET • WICHITA, KANSAS
OIL FIELD DISTRIBUTORS FOR WISCONSIN ENGINES AND ALL TYPES OF UTILITY UNITS



Make room for oilmen on the Limited. Our seagoing geologist doesn't usually travel with his coral samples. But they're clues in the search for oil, and he's making the point that oilmen help railroads carry people and freight from here to almost anywhere. The latest count tallied 440 million passengers and 2.5 billion tons of freight in one year. So if your seat mate on the train doesn't know the facts and talks against the oil industry, tell him you're an oilman and proud of it. And tell him why. **SHELL OIL COMPANY**

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

• Industry
• People
• News

The Trade PARADE

West Coast unit streamlined. Streamlining of its far west operations has been effected by Johnston Testers, Inc. in the move to a new structure in Long Beach, California. This is now the headquarters for Johnston's western area and Los Angeles basin district which were moved from Los Angeles. Heading the western area as manager is R. H. Stainer.

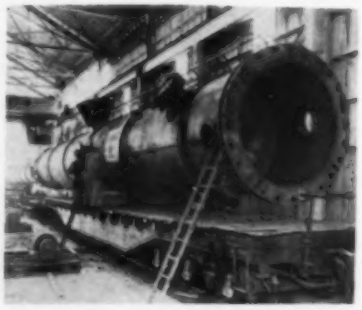
Bendix Expands Computer Plant

The Computer division of Bendix Aviation Corporation has announced an expansion program that doubles the size of its manufacturing facilities in Los Angeles. The expansion will enable the firm to increase production of their general purpose computer by over 100 machines annually.

GREEK MINE NOW PROCESSING barite. Another goal is about to be achieved in Dresser Industries' plan for serving the world-wide petroleum industry, according to J. B. O'Connor, Dresser president. On the ancient Greek island of Mykonos, O'Connor will attend the formal opening of a modern mill for processing high-degree barite which is being mined on the island. Magcobar (Magnet Cove Barium Corporation, Houston, Texas), one of the Dresser Industries, will process the barite into Magcobar drilling mud for use by oil drillers in the Middle East, Europe, North Africa, and elsewhere throughout the world.

CONSTRUCTION IS EXPECTED TO start on the expansion of the Magnet Cove Barium Corporation office and laboratory building at 3133 Buffalo Speedway, Houston, Floyd A. Enz, vice president and secretary-treasurer has announced. The construction contract will be put up for bids this month. Target date for completion of the expansion is one year after construction begins. The proposed expansion will add 33,500 sq ft to the Magcobar facility and more than double the building's present 29,000 sq ft. Another 4000 sq ft will be added to an adjacent garage building.

SUCCESSFUL COMMERCIAL EXtrusion of tubing made of molybdenum, a metal particularly suited for nuclear power plants, jet engines, rockets and missiles, was announced by Wolverine Tube, division of Calumet & Hecla, Inc. The new extrusion process was developed by Wolverine Tube engineers in cooperation with Climax Molybdenum Company, which supplied the molybdenum billets as well as basic data on the metal's characteristics. In the past, the high strength of the material at extrusion temperatures had been a barrier to successful extrusion. Molybdenum, which is stronger than any other known metallic material at temperatures in excess of 1700 F, also resists corrosion by liquid metals. Dimensions of the tubing are: Less than 1 in. OD; approximately 0.1 wall thickness; and 3-6 ft in length. Tensile strength is 70,000-100,000 psi and yield strength is 60,000-90,000 psi.



Largest Tulsa shipment. One of the largest single pieces of equipment ever to be shipped from Tulsa left by rail from McNamar Boiler and Tank Company. Three special triple truck and 2 standard double truck flat cars were required to ship the rich oil demethanizer to Union and Exploration Company's Unatex gasoline plant, located near Eunice, Louisiana. The huge vessel, 162 ft long by 9 ft in diameter and weighing 250,000 lb, was fabricated by McNamar here for the Fluor Corporation, Limited, contractors for the new Union plant.

OPERATION DATA, FEATURING Consolidated Electronics Corporation's mobile instrument exhibit, is again bringing the latest developments in electronic instrumentation to the doorsteps of major industrial plants and airplane installations. The exhibit, housed in a colorful, 17-ton truck-trailer, left Pasadena this week and will cover more than 30,000 miles before returning home sometime in February 1958. Working demonstrations of CEC's newest instruments will be given engineers and technicians in almost every section of the country and in Ottawa and Montreal, Canada. In addition, the CEC products will be exhibited at 2 major trade shows. During the past 3 years, the mobile unit has traveled 90,000 miles, showing Consolidated's products to more than 25,000 customers and prospective customers.

• CORROSION RESISTANT LINE
• 20 Ounce BRASS PLUMB BOB
• 50% HEAVIER LINE

EASY TO READ MARKINGS THAT ARE DURABLE

LUFKIN

"ATLAS" CHROME CLAD
OIL GAGING TAPE

Atlas lines are 50% heavier than standard weight steel tapes. Full 20-ounce solid brass plumb bob penetrates heavy oils. Easy to read. Bold black markings contrast with exclusive "glare-free" Chrome Clad surface — oil level shows clearly. Multiple platings prevent rust and corrosion. Wipes clean. Lines are replaceable. Lengths from 18 to 100 feet.

BUY LUFKIN TAPES • RULES PRECISION TOOLS FROM YOUR SUPPLY HOUSE

THE LUFKIN RULE COMPANY
SAGINAW, MICH.
New York City
Barrie, Ontario

BETTER MEASURE WITH LUFKIN

389

In Aluminum too...

...a three-way saving in your piping dollars

When you specify TUBE-TURN* products, you are sure of getting the exact fittings for your job because the Tube Turns' line is the world's most complete . . . *you save engineering time.* Your welders can work faster because fittings are completely identified and perfectly uniform . . . *you save construction time.* You can buy all your fittings with one order from your nearby Tube Turns' Distributor . . . *you save purchasing time.* Are *you* getting these savings in piping costs?

*"TUBE-TURN" and "tt" Reg. U. S. Pat. Off.

Installation of aluminum piping for handling ammonium nitrate.

The Leading Manufacturer of Welding Fittings and Flanges

TUBE TURNS

LOUISVILLE 1, KENTUCKY

A DIVISION OF NATIONAL CYLINDER GAS COMPANY

DISTRICT OFFICES: New York • Philadelphia • Pittsburgh • Chicago • Detroit • Atlanta • New Orleans • Houston • Midland • Dallas • Tulsa • Kansas City • Denver • Los Angeles • San Francisco • Seattle. **IN CANADA:** Tube Turns of Canada Ltd., Ridgetown, Ontario • Toronto, Ontario • Edmonton, Alberta • Montreal, Quebec.

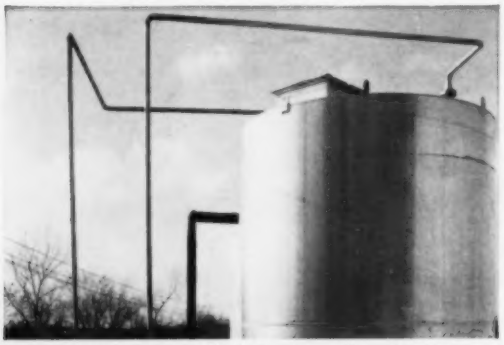
OTHER APPLICATIONS SHOWN ON REVERSE SIDE ▶

In Aluminum piping too...

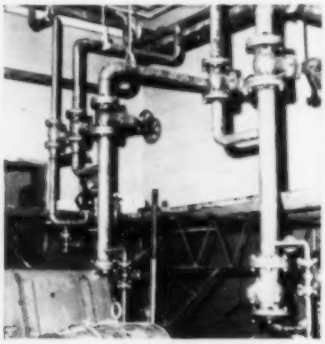
You save manhours with the line of 12,000 TUBE-TURN® products

LIQUID SUGAR. Part of welded aluminum piping system for processing of liquid sugar. When you specify TUBE-TURN® products, you can count on getting the right type, size, schedule and material for every piping service. Saves engineering manhours.

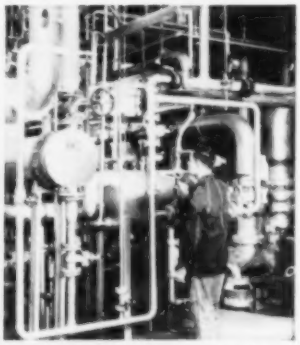
"A-POWER." These TUBE-TURN Aluminum Elbows are for nuclear swimming pool reactor water-coolant lines. Tube Turns' experienced engineering service helps you solve piping problems of all kinds. Contact your nearby Tube Turns' Distributor or District Office.



OLEIC ACID. These welded aluminum lines for oleic acid storage show how this strong but lightweight construction can be utilized for corrosive service. Your nearby Tube Turns' Distributor can give you complete-line service promptly . . . to help you save purchasing time.



REFINERY CATALYST is handled by this aluminum piping, equipped with TUBE-TURN welding fittings and flanges. Uniformity of TUBE-TURN products saves construction manhours



PURE WATER. Passive aluminum piping guards against contamination in this water purification plant. You can buy *all* your fittings with *one* order when you specify TUBE-TURN products.

NEW BOOKLET—This new Tube Turns catalog gives helpful information on aluminum pipe, fitting and flange materials. Mail the coupon for your free copy.

TUBE TURNS, Dept. K-7
224 East Broadway, Louisville 1, Kentucky

Please send free copy of new catalog on Aluminum Fittings and Flanges.

Company Name _____

Company Address _____

City _____ *Zone* ____ *State* _____

Your Name _____

Position _____

Available from your nearby TUBE TURNS' Distributor

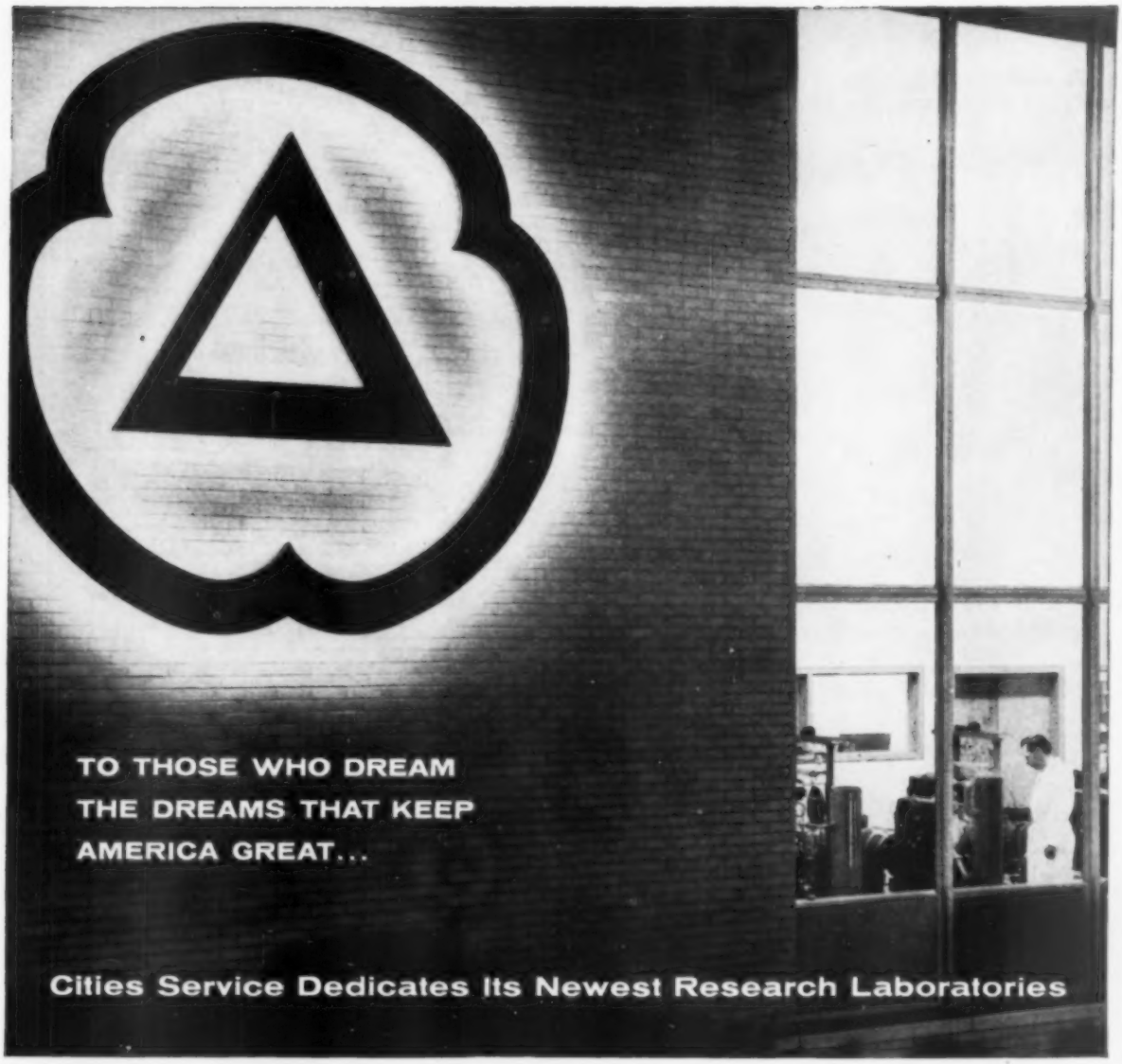
*"TUBE-TURN" and "tt" Reg. U. S. Pat. Off.

TUBE TURNS

LOUISVILLE 1, KENTUCKY

A DIVISION OF NATIONAL CYLINDER GAS COMPANY

DISTRICT OFFICES: New York • Philadelphia • Pittsburgh • Chicago • Detroit • Atlanta • New Orleans • Houston • Midland • Dallas • Tulsa • Kansas City • Denver • Los Angeles • San Francisco • Seattle. **IN CANADA:** Tube Turns of Canada Ltd., Ridgetown, Ontario • Toronto, Ontario • Edmonton, Alberta • Montreal, Quebec.



Cities Service Dedicates Its Newest Research Laboratories

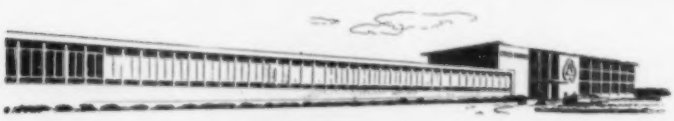
Cities Service believes it is altogether fitting that its splendid new research laboratories at Cranbury, New Jersey were dedicated to those who will use them so wisely and well.

Often unsung, sometimes unappreciated, the men of science in the industrial laboratories of the country are a national resource beyond the command of money.

They kindle the fires of imagination and keep them burning. They spark the constant development of new products and the continual improvement of established ones. Because of their dedication to the new and better, management can build, salesmen can sell, every business can grow in usefulness, and the public benefits.

Joining four other great Cities Service laboratories, these newest facilities will provide the most advanced equipment for research in petroleum and allied fields. Included is a modern nuclear section for long-range research in the field of process development, fuels and lubricants—the heart of which is the largest concentration of irradiated cobalt ever to be supplied by the Atomic Energy Commission's Brookhaven National Laboratory.

Cities Service is proud, indeed, of its modern new laboratories and their advanced equipment . . . but takes far greater pride in the men who will man them. It's their dedication and skill that spark our growth and our service . . . for today and for tomorrow.

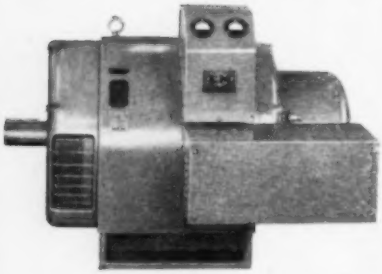


CITIES SERVICE

Get the latest!

A COMPLETELY NEW "PACKAGED" GENERATOR

AMP-PAK



AMP-PAK Generator shown is rated at 187 kva, 1200 rpm, 240/480 volts. AMP-PAK is available in ratings of 75 thru 187 kva at 1800 rpm and 62½ thru 187 kva at 1200 rpm. Three phase, 80% PF, 60 cycles, 50C rise, and 120/208, 240 and 480 volts.

No exciter . . . No moving parts in the voltage regulator

AMP-PAK is a compact, revolving field a-c generator with built-in, static excitation system; static voltage regulator; and basic metering and controls conveniently grouped. AMP-PAK is a portable unit, factory assembled, internally connected, and tested.

No rotating exciter to maintain. D-C excitation is provided by a heavy duty, long-life, static rectifier.

No tubes, relays, vibrators to service. Voltage is regulated by a static, E-M-developed sensing circuit and "magical" magnetic amplifiers.

Holds voltage "rock-steady" so your motors, lights, and electronic equipment will work better. The static regulator provides ±2% regulation.

Starts big motors. A special, built-in voltage booster transformer stands by to reinforce line voltage when heavy loads are suddenly applied.

Easy to install. Needs no switchboard. Just connect load to AMP-PAK thru a suitable line switch.

Simple to operate. Has no belts, no "tricky" commutator, no adjustments – anyone can operate AMP-PAK.

See your nearest E-M Sales Engineer and write the factory for publication PRD-236.

E-M

ELECTRIC MACHINERY MFG. COMPANY
Minneapolis 13, Minnesota

Largest manufacturer of "Packaged" Generators

2100-TPA-2154

Trade Parade

VENEZUELAN FACILITIES EXpanded. The office and warehouse of the western division of Oilfield Sales and Service, S.A. located in Urbanizacion Sucre front of Plaza in Maracaibo, Venezuela, has recently been enlarged and remodeled. To accommodate the increased activity on the eastern side of Lake Maracaibo, a new warehouse has also been completed in Tia Juana. Operations of the western division are under the direction of Jerome C. Kearby.

PERFORATING GUNS ATLAS CORporation has opened new stations at Shreveport, La.; Buras, La.; Magnolia, Arkansas; Farmington, N. M.; Crane, Texas and Laurel, Mississippi. Men in charge include Lee Buel at Buras, J. E. Crouch at Magnolia, J. S. Rhodes at Farmington, W. E. McCarroll at Crane and J. H. Rodgers at the Laurel station.

ALLIS CHALMERS MANUFACTURing Company has broken ground for a new $3,250,000 engineering and research laboratory at Harvey, Illinois. It will provide central engineering, engine and material handling development, and engine test facilities.

MILTON ROY COMPANY, MANUfacturing engineers of Philadelphia, announces the purchase of Anders-Lykens Company of Lykens, Pennsylvania, manufacturers of instrument air dryers and gas dehydrators. This merger will provide the Anders Division with the necessary backing to realize its growth potential more quickly. At the same time, it broadens Milton Roy's product lines for instrumentation and control systems for the chemical processing industries.

AN ANALYTICAL AND CONTROL Instrument Division has been established by Consolidated Electrodynamics Corporation. Products will include CEC's established line of mass spectrometers, chromatographs, moisture monitors, and other analytical, control, and process-monitoring equipment. The unit, to be housed in the company's main plant facilities in Pasadena, brings to eight the number of divisions operated by CEC in Southern California. Consolidated also has a high-vacuum division in Rochester, N. Y.

FLEXONICS CORPORATION, WILL build a new plant on a 10-acre site at Santa Ana, California. The plans to extend the firm's manufacturing facilities to the West Coast have been announced by John F. P. Farrar, president. Construction is expected to begin shortly on an initial building of 25,000 sq ft. The Santa Ana division, now being formed, is the firm's second major expansion move in the past 6 months. The company has 6 factories and 2 assembly plants in the United States, besides a Canadian subsidiary, Flexonics Corporation of Canada, Ltd., 15 field offices in principal U.S. cities and agents in 30 foreign countries from the network of a world-wide distributing system.

SARGENT ENGINEERING CORPOration announces the expansion of their manufacturing facilities. New expansion will add substantially to the production facilities for conventional and hydraulic deep well pumping systems.

RIVES, DYKE AND COMPANY OF Houston has been appointed advertising agency for the Petroleum Equipment Suppliers Association.

#55 FACED MECHANICAL SEALS RESIST WEAR AND CORROSION

#55 FACING MATERIAL

THIS BULLETIN TELLS THE STORY

. . . For further details write today for a copy of Bulletin No. 469 PE

•

**ROKIDE Process Coating developed by the Norton Co. of Worcester, Mass.*

A new and superior facing material is now available on the engineered mechanical DURA SEAL. #55 faced seal rings are long-wearing, operate at extremely high or low temperatures, and present highest resistance to wear and corrosion. #55 Facing Material combines the low-friction benefits of ceramic materials with the strength and resistance of alloyed steels.

DURAMETALLIC CORPORATION
The PERFECT SEAL
KALAMAZOO MICHIGAN

THE CASE OF
THE OWNER WHO THOUGHT AHEAD
ART, THIS CAT* CARE SCHOOL SHOULD PAY OFF WHEN WE START ROLLING NEXT SPRING!
CAT
-AND SPEAKING OF SPRING, I'M GOING TO NEED SOME SERVICE WORK ON MY MACHINES TO BE SURE THEY'RE READY.
NOW'S THE TIME TO THINK OF THAT, TOM!
SUPPOSE WE MAKE UP A SCHEDULE FOR WINTER SERVICING OF YOUR EQUIPMENT. THAT WAY WE'LL GET THE MACHINES BACK ON THE JOB FASTER-MAKING MONEY FOR YOU.
NSON
RUCTION CO.
CATERPILLAR
SWELL! LET'S START WITH MY D6 ON MONDAY. WE'LL BRING IN THE OTHER EQUIPMENT ON A SCHEDULE AFTER THAT.
MONDAY'S FINE! NOW, LET'S MAKE A LIST OF JUST WHAT NEEDS TO BE DONE...
CATERPILLAR*
*Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.
CAT CARE FOR LONGER WEAR
LET ME SCHEDULE YOUR WINTER SERVICE NEEDS FOR YOU!
Caterpillar Tractor Co., Peoria, Illinois, U.S.A.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

PEOPLE

S. A. Garee

Jess D. McClendon

Samuel A. Garee has been appointed manager of operations for The Gas Machinery Company, Cleveland. He formerly was with Gas Atmospheres, Inc.

Jess D. McClendon has been appointed division sales manager, with headquarters at Torrance, for National Supply Co.

Farrel-Birmingham Company, Inc. has appointed **Philip H. Dreissigacker** sales manager in charge of sales and engineering.

Board of directors of The Diamond Chain Company, Inc., elected **G. E. Schloot** president. **C. A. Turner,** assistant personnel manager will succeed Schloot as personnel director. **William V. Covert,** chief engineer and **Benjamin K. Sollars,** factory manager, were elected to the board.

Lyman D. Warner has been named manager of subsidiaries of Dresser Manufacturing Division. The subsidiaries group includes Dresser Mfg. Ltd. of Toronto, Dresser England, and the Special Products Department of Dresser Mfg. Div.

Lawrence A. Huff has been appointed general manager of Charles Wheatley Company, Tulsa. Huff has served for 8 years with the Wheatley firm, most recently as head of the purchasing department, which duties he will continue to hold.

L. A. Huff

R. E. Barnett

Marsh Instrument Company and affiliates announce the appointment of **Robert E. Barnett** to the position of sales manager. Barnett joined the Marsh sales staff in 1941.

Pittsburgh Coke & Chemical Company has promoted two executives to head activities of Protective Coatings Division. **Norman T. Shideler** was elected president of Insul-Mastic, Inc., a newly acquired subsidiary, and **Arthur E. Gray** was named to succeed Shideler as the division's general manager.

Paul R. Soule, Jr., has been appointed vice president in charge of sales for Texoma Supply Co. Soule has for the past 5 years been assistant sales manager for the chemical division of John Deere, following 7 years of experience in manufacturing and engineering.

P. R. Soule, Jr.

C. L. Ward

Charles L. Ward, an engineer with extensive experience in the field of diesel engines has been named assistant to the general manager for Stewart & Stevenson He will be located in Houston.

Parkersburg Rig and Reel Company has opened new branches at Liberal, Kansas, with **J. W. Bower** as branch manager and at Farmington, New Mexico, under the managership of **W. H. Clayton.**

Blaine Johnston

W. B. Jennings

Engineered Oil Tools, Inc., a new company formed this year to manufacture and market Johnston Hydraulic Pumping Units, names **Blaine Johnston** general manager and **W. B. Jennings** as central division manager.

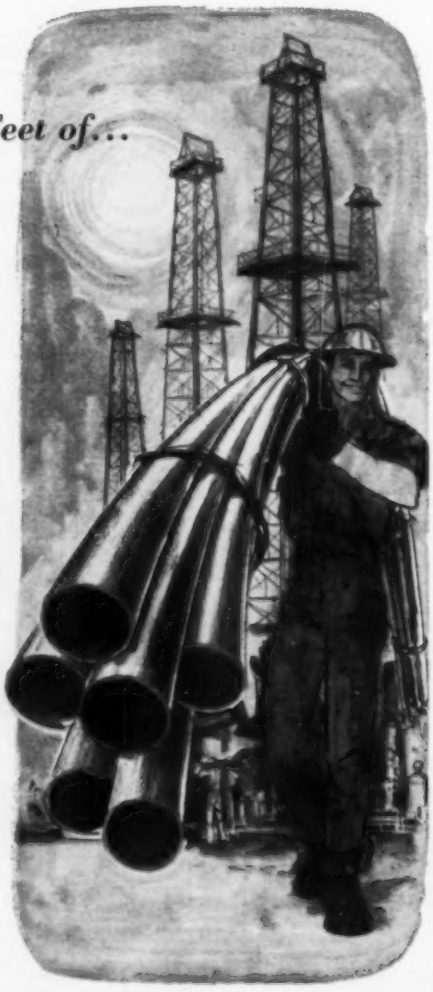
Over One Million Feet of...

KRALOY

HIGH-IMPACT

PVC PIPE

in oil-country use today



This proves that there is no substitute for Kraloy experience.

KRALOY is the most experienced manufacturer of PVC plastic pipe for the petroleum industry. The first polyvinyl chloride lead line installed in this country—at Great Bend, Kansas—was Kraloy Pipe. Kraloy High-Impact PVC today is preferred by production men for maintenance-free service in lead lines and disposal systems. Kraloy customers use Kraloy High-Impact PVC pipe for lead lines, gas lines, and salt water lines because Kraloy normally eliminates (1) sulphur corrosion due to sour crude, (2) paraffin buildup, (3) corrosion and scale, (4) trouble from soil electrolysis.

YOU Benefit From KRALOY'S Quality Control

To insure quality control, random samples of Kraloy Plastic Pipe are tested daily in Kraloy's own laboratory for burst pressure, impact resistance, and tensile strength under standard ASTM specifications.

Kraloy Pipe is Sold Only Through Qualified Supply Stores

Warehouse stocks and sales representatives:

Great Bend, Kansas:
Robinson Oilfield Specialties Co.,
616 Main St.

Tulsa, Oklahoma:
The Becker Sales Company,
2837 Sands Spring Rd.

For case histories of actual Kraloy installations, cost comparison tables between Kraloy and other pipe, plus detailed instructions and specifications for all field uses, write to:

KRALOY *plastic pipe co., inc.*

4720 East Washington Boulevard, Los Angeles, Calif.

Subsidiary of the Seamless Rubber Co., a Rexall Drug Co. Subsidiary

GP-100

Madden T. Works is new manager of operations of the Turbodrill Division, Dresser Industries. In this position, Works will be in charge of development engineering, the manufacturing department, and the field service department of the new Dresser division. He was president of Pioneer Specialties, Inc., of Houston, a manufacturer of oilfield equipment.

Madden T. Works

R. H. Engstrom

Ralph H. Engstrom has been named assistant vice president in charge of sales for the RegO Division of the Bastian-Blessing Company of Chicago. The office of assistant vice president has been newly created.

Four personnel changes in the export division of The National Supply Company have been announced. **Charles T. Reichert** has been appointed manager of the London office. He replaces **R. B. Rogers** who has retired. **Howard C. Tait** has been appointed area manager for Venezuela, Mexico, and Alaska. **Galen L. Lindner** has been appointed export division engineer, replacing Tait. **James M. Davies** has been appointed district manager for Eastern Venezuela with headquarters at Anaco.

E. C. Zografos has been appointed manager of advertising and sales promotion for Baash-Ross Tool Company, Houston.

R. C. "Bob" Brenner has been made Gulf Coast area sales manager.

Appointment of **Robert F. Gibson** as manager and **E. Ray Hester** as assistant manager of the installation and service department is announced by Engine Division, Nordberg Manufacturing Company.

R. F. Gibson

E. R. Hester

Edward L. Carlson, advertising manager of Oakite Products, Inc., has been placed in overall charge of the company's informational efforts in the industrial cleaning and metal finishing fields.

New store managers for Mid-Continent Supply Co. are **J. D. Gilmer**, Great Bend, Kansas, **F. C. Stickney**, Eunice, New Mexico and **A. M. Thompson** at Laurel, Mississippi.

William Becker has been appointed district manager of the newly formed National Sales Company, California subsidiary of National Tank Company.

A. R. Patton has been appointed Eastern Venezuela district sales manager for Security Engineering Division.

Let it pound away!

It's a Kennametal Ball and Seat, and will stay on the job from 3 to 5 times longer than "special alloys" and give 20 times the service of steel. Even under the most severe conditions, balls and seats of Kennametal* or Kentanium* stay down longer, cut well downtime, keep production high. Here's your answer to:

Fluid cutting	Ball pounding
Wear	Ball-on-seat shock
Corrosion	Electrolytic action

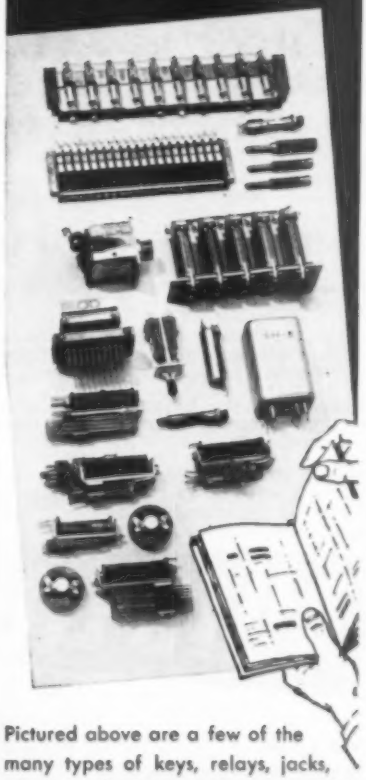
Two grades are available. Kennametal grade KH is suggested for use under high abrasive cutting conditions. Kentanium, one-third lighter than steel, is recommended for use in applications where cage wear, corrosive sand, sulfide fluids, and seat impact are severe.

Ask your regular pump service man, or write KENNAMETAL INC., Dept. PE, Latrobe, Pa.

*Trademarks of a series of hard carbide alloys of tungsten, tungsten-titanium and tantalum. C 3069

INDUSTRY AND
KENNAMETAL
...Partners in Progress

which
of these quality
COMPONENTS
do you need?



Pictured above are a few of the many types of keys, relays, jacks, plugs, and other components which Kellogg supplies to industry. 60 Years of experience stands behind the reliability of these important parts. Write today for your Kellogg Industrial Catalog.

KELLOGG SWITCHBOARD AND SUPPLY COMPANY
A Division of International Telephone and Telegraph Corp
Sales Office: Dept. 80-J, 6650 S. Cicero Ave., Chicago 38, Ill

KELLOGG
A DIVISION OF I T & T
60 YEARS

KELLOGG SWITCHBOARD AND SUPPLY CO.
A Division of
International Telephone and Telegraph Corp.
QUALITY COMPONENTS FOR INDUSTRIAL CONTROL
QUALITY COMMUNICATIONS SYSTEMS

Trade Parade

W. O. Kupper has been elected manager of sales projects, a new sales division of Jones & Laughlin Supply Division.

Richard H. Perley has been appointed vice president and general manager of Hycon Aerial Surveys, Inc.

R. H. Perley

J. S. Wintringham

John S. Wintringham has been named senior research advisor at the Ethyl Corporation Research Laboratories in Detroit, Michigan. He will be responsible for technical coordination and liaison with the petroleum industry.

Appointment of **Robert D. Ridgway** as manager of sales operations, Consolidated Electrodynamics Corporation, has been announced.

Byron A. Haney has been appointed northwestern sales manager for Bucyrus-Erie Co.

Franklin Supply Company announced the appointment of **James E. "Ed" Farrell,** as vice president.

Haskell Wotkyns has been elected executive vice president of Maloney-Crawford Tank and Manufacturing Co.

John E. Metzenthin, sales engineer for Crouse-Hinds Company in Dallas, Texas, was elected president of the Petroleum Electric Supply Association at the annual convention at Houston, Texas.

Appointment of **Charles E. Martin** as general service manager and member of the executive committee of the Cummins Engine Company, Inc. of Columbus, Indiana, has been announced. As general service manager, Martin assumes overall responsibilities for the service division of the company. **Paul J. Every** has been appointed managing director of Cummins Engine's subsidiary in Shotts, Lanarkshire, Scotland, and has left to take over his new duties. Every had been the Cummins general sales manager at the parent plant at Columbus, Indiana, before being appointed to his new position in Scotland.

C. E. Martin

J. E. Chadwick

John E. Chadwick, sales manager of Koehring Div., Milwaukee, has been named vice president and sales manager in charge of sales, service and sales promotion.

McCullough Tool Company has formed a new operating district, called "Four Corners District" in the Four Corners Area of New Mexico, Colorado, Utah and Arizona. Four Corners District is under the management of **John W. Coulter,** district manager. Assisting Coulter are branch managers **R. L. Walker** and **B. L. Martin.**

J. W. Coulter

D. P. Hagaman

The promotion of **D. P. Hagaman** to sales manager of W. C. Norris, Manufacturer, Division of Dover Corp. has been announced. Hagaman has been with the company for 21 years and since 1956 has held the position of assistant sales manager.

Donald Williams, vice president and director of sales, has been appointed to the newly created position of director of corporate relations for The Dow Chemical Company.

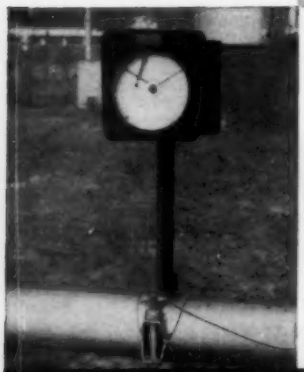
S. Merle Hardison has been appointed district manager in Philadelphia for Tube Turns, division of National Cylinder Gas Company.

Larkin of Butler has appointed **Tom Tobin** to its sales force to represent Larkin and Company, Inc., in Eastern areas.

AUTO-LITE

...for TEMPERATURE RECORDING...

One of the many uses for Auto-Lite Recorders is the application shown below . . . a natural gas field meter run.



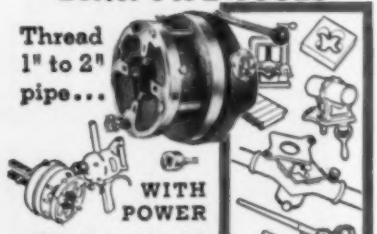
Auto-Lite Model "1000" Temperature Recorder has 6" chart. Various standard ranges from minus 40° F to plus 550° F. Available for wall mounting, portable or portable self contained use. Electric or mechanical chart drive. Choice of 24-hr. or 7-day cycle. Capillary tubing permits remote reading. Priced as low as $49.50. Manufactured to customers' specifications. Send for latest Catalog describing many types of Auto-Lite Recorders and Indicators.

THE ELECTRIC AUTO-LITE COMPANY
INDUSTRIAL THERMOMETER DIVISION
TOLEDO 1, OHIO
NEW YORK • CHICAGO • SARNIA, ONTARIO

TEMPERATURE RECORDERS & INDICATORS

ARMSTRONG BROS.
Better PIPE TOOLS

Thread 1" to 2" pipe...



WITH POWER

This light (26 lb.) compactPortablePower Pipe Threader, goes to the job—is operated with a ½" portable electric drill. 1 set of High Speed Steel Chasers do all sizes—just move indicator to 1", 1¼", 1½", or 2" marking. Clamp on pipe and apply drill to drive square. The rest is automatic. Operating on anti-friction bearings with automatic lead, it's a fast, easy way to get smooth, accurate threads.

Write for Catalog

ARMSTRONG BROS. TOOL CO.
5231 W. ARMSTRONG AVE., CHICAGO 30, ILL.

Here's how you can get

MORE EFFICIENT OIL RECOVERY from your flooding operations:

Typical INFILCO flooding water treatment plant includes: Forced Draft Aerators; "ACCELATOR" Treating Plants; Chemical Feeders and INFILCO Pressure Filter Plant.

INSIST upon these standards for your flooding medium

1. Chemical stability
2. Oil content zero
3. Iron content 0.2 parts per million
4. Turbidity 1 part per million

Most operators agree that these standards for the flooding medium (water, produced brine, or both) are necessary to minimize clogging of the input formation. INFILCO *complete* treating plants, which include the highly efficient ACCELATOR® Stabilizer, provide water within the specified limits. Closed systems, or other types of partial treatment, seldom meet these exacting requirements.

Existing INFILCO installations are treating over 500,000 barrels per day with three-way economy: lower first cost, lowest maintenance and low, low chemical costs. INFILCO engineers have over 30 years experience in designing *complete* flooding water treatment plants. Be sure you are getting maximum oil recovery by consulting your nearby INFILCO engineer. If you prefer, write for complete information.

THE **ONE** COMPANY offering equipment for **ALL** types of water and waste treatment

INFILCO

INFILCO INCORPORATED

General Offices • Tucson, Arizona • P.O. Box 5033

5618A

R. J. Keller has been named chief engineer of the A. O. Smith Corporation's welding products division, which manufactures electrodes, welding equipment and direct current power sources.

C. W. Mohr is manager of the industrial sales department of Gustin-Bacon Manufacturing Company.

William J. Burke has been appointed director of sales for the Texas-U.S. Chemical Company.

P. T. Francis has been named sales manager of Quelcor, Inc., Chester, Pennsylvania. Francis will coordinate the establishment of commercial applicators and the installation of Quelcor In-Plant Systems in addition to heading the sales of the company's PVC products.

James Beré has been named president of Axelson Manufacturing Company. Axelson, located in Los Angeles, California, is a division of U.S. Industries, Inc.

James J. Barrett has been appointed manager of extrusion sales for The Babcock & Wilcox Company's tubular products division. In the newly created position, Barrett will direct the sales of hollow and solid extrusions.

Baker Oil Tools, Inc., appointed **Ing. Hans Szepanek,** of Celle, Germany, as technical representative for West Germany and Austria. He will also act in a similar capacity in such other European countries as time and circumstances permit.

Here's the spark plug for CLARK® ENGINES

STITT NEW TRIPLE IGNITORS

Clark is now factory-installing STITT new Triple Ignitor Spark Plugs in Turbo Charged engines . . . Bring your Clark engines up to date—repower them with STITTS which give you longer life, cut downtime, increase magneto life. STITTS are also factory equipment in Waukesha, Cooper-Bessemer, Worthington, other leading engines

Write today for FREE pocket booklet giving recommended plugs for all engines—you can get better plug performance.

STITT

STITT IGNITION CO.
COLUMBUS 1, OHIO

STITT MAKES HEAVY-DUTY, INDUSTRIAL-TYPE PLUGS!

every tracing's a top tracing in a . . .

Hamilton Shallow Drawer Unit

This remarkable, ten drawer file safely stores 1000 tracings, yet any one of them is instantly available.

There's a patented *tracing lifter* in each file drawer. Just raise the lifter, locate the desired drawing, and fold back all the sheets above it. *The tracing you want is now on top* —easy to slip out and replace with no danger of wrinkling or tearing.

Here's a fast and safe way to handle your valuable active tracings—and only Hamilton Shallow Drawer Units have it!

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HAMILTON MANUFACTURING COMPANY
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For all reciprocating pumps, regardless of size, age, or model . . . in Bronze and Stainless Steel to meet every need, providing long service at pressures up to 1,500 P. S. I. and temperatures up to 300°F. Special sizes on request.

- **Nylon Plate** — Insures long life in all fluids, except Phenol, Formic Acid or Concentrated Mineral Acids.
- **Cone Type Spring** — Fully corrosion resistant; cone construction lengthens life of spring, eliminates coil wear.
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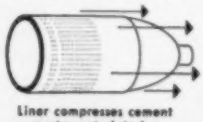

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Gives smooth, continuous, water proof lining of correct thickness

Tate Process applies cement mortar lining to the interior of 4" to 16" lines quickly and economically . . . while the lines stay "in place." Permanently restores full flow coefficients. Reduces pumping and maintenance costs. Protects against corrosion, contamination.

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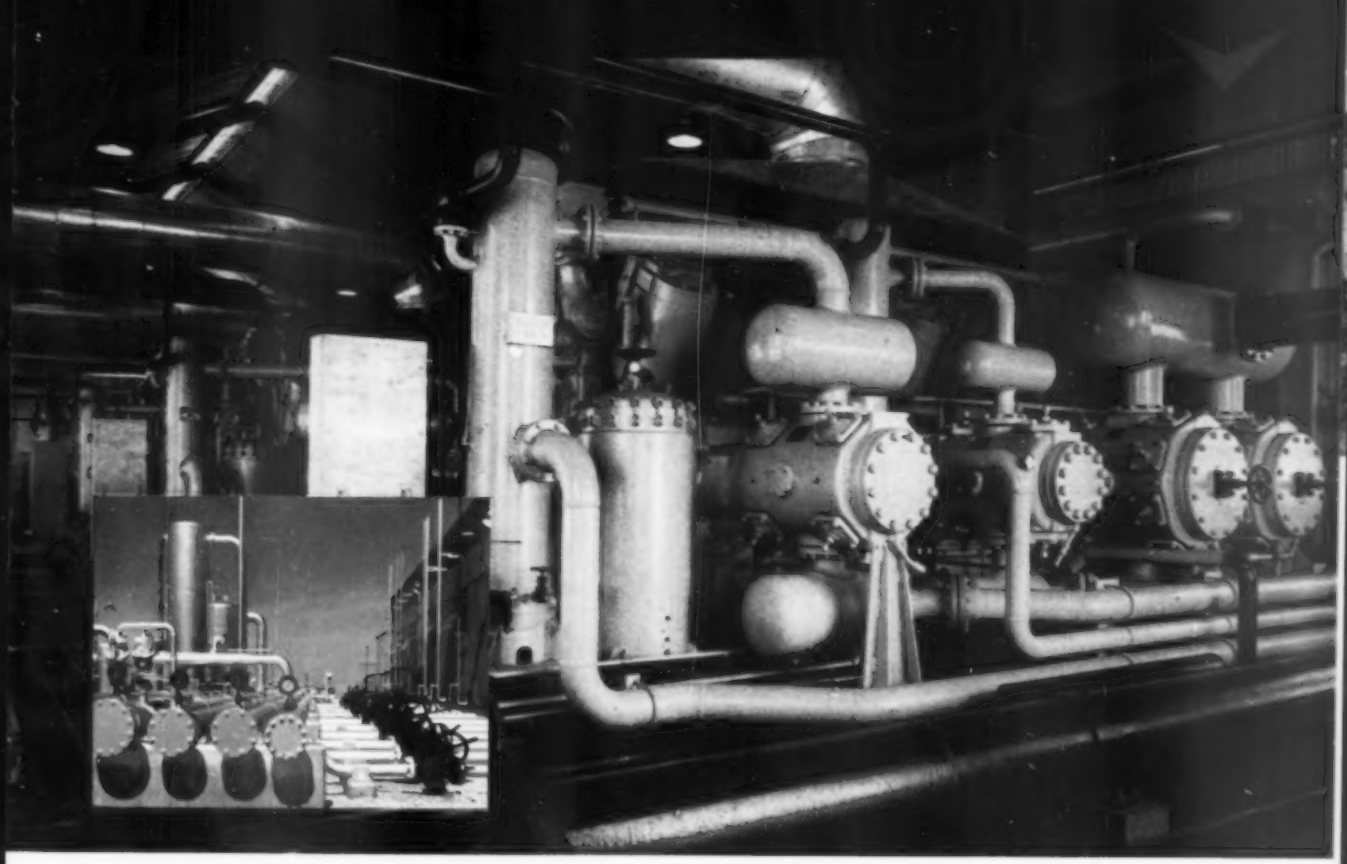
BEAIRD-INGERSOLL-RAND Packaged Compressor Plant



REEF FIELDS GASOLINE CORPORATION'S Good Field Compressor Station—equipped with five Beaird-Ingersoll-Rand 660 h.p. 12SVG packaged compressors . . . Young radiators and all necessary controls. Other sizes 120 to 660 h.p.

Boost Gas . . .

PACKAGED COMPRESSORS HANDLE 278 SPRAYBERRY WELLS

Reef Fields Gasoline Corporation built the Good Field Compressor station to boost separator gas from low pressure wells to a natural gasoline plant sixteen miles away. Originally planned to handle Good Canyon Reef Field, the station has now been expanded to gather gas from the Jo-Mill Sprayberry Field. Five Beaird-Ingersoll-Rand 12SVG 660 h.p. packaged compressors have been installed to handle this increased load.

Picking up from the wells at 3 psig. the units boost the gas through three stages of compression to discharge at 600 psig. At present 278 wells are tied into the station which has a total volume of 18,000 MCF per day. Of this capacity, the five Beaird units recently added, are handling 12,000 MCF per day.

Packaged compressors were selected for the Good Field Station as total compressor requirements cannot be determined until the Sprayberry field is fully developed. Also the field is expected to have a relatively short life. As production tapers off, the units can be moved one at a time with little or no change to other service. The remaining units can be kept fully loaded in this manner until the field is depleted.

Let us give you all the facts about the economy of installing multiple Beaird-Ingersoll-Rand packaged compressor plants.

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another AMF product
PACKAGED COMPRESSOR PLANTS

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ANTI-STALLING ADDITIVE

GULF AGENT 178

... proved by over 25 billion miles of stall-free driving!

GULF AGENT 178 provides economic, effective anti-stalling performance in motor gasolines. At the same time, it affords corrosion protection at no extra cost.

Look at what GULF AGENT 178 offers you:

PROVED PERFORMANCE—GULF AGENT 178—long recognized as an outstanding corrosion inhibitor for all types of petroleum products—is now used by major refiners in modern volatile motor gasolines to eliminate stalling caused by carburetor icing . . . and its effectiveness for this use has been proved in service by over 25 billion miles of stall-free driving.

LOW COST—Small concentrations—15 to 25 pounds per thousand barrels—give anti-stalling protection at as low as 1/10 the cost of commonly used de-icing additives.

EASE OF USE—GULF AGENT 178 is readily soluble in all petroleum products—can be easily blended at temperatures ranging from minus 30 to plus 140° F. Also, it is insoluble in water and can be handled in conventional gasoline transfer systems with no danger of loss from water leaching.

MINIMUM STORAGE—The small concentrations required eliminate need for expensive additive storage.

EXTRA BENEFITS—Rust protection it provides lengthens life of distribution and storage facilities from refinery to customer.

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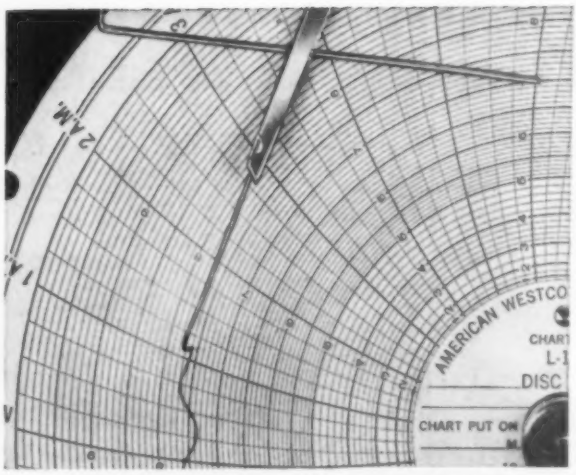

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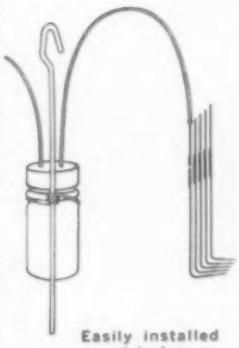
assure legible charts ...eliminate inking problems



Easily installed as original or replacement equipment in all standard recording instruments. Available in five sizes and angles—special pens upon request.

Cannon controlled-flow capillary meter pens provide exceptional dependability and long life with minimum maintenance. Easy to install, these precision pens produce accurate chart records of maximum legibility and continuously record up to a full year without refilling reservoir.

- **Ends Unrecorded Intervals.** Unaffected by pulsating flows, chart speeds, rapid pen movement.
- **Sealed Ink Supply.** Prevents clogging from atmospheric contamination.
- **Two-Way Ink Flow.** Stainless steel writing point is positioned above ink level in reservoir and ink flows in either direction by capillary action—eliminates smearing, blurring.
- **Special Pens.** Designed and produced to customer specifications where special inking problems make standard pens impractical.

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HIGHEST WELL PRESSURE EVER!

—Certified by MARSH

Yes, 11,400 psi!

This was oil country drama at its best: bringing in the "2 Elue Roach" well in Union Oil & Gas Corporation's spectacular Lake Arthur Field at Jefferson Davis Parrish, Louisiana. The Marsh Gauge climbed to 11,400 psi; later reached 11,600 psi—highest shut-in tubing head pressure ever registered by an oil well, and by a good margin.

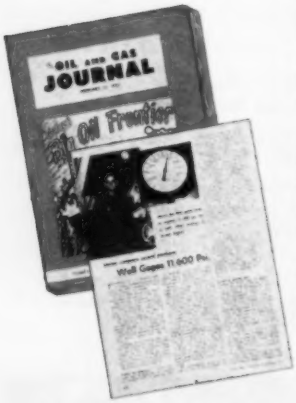
Only a few years ago oil companies were refusing to complete wells that threatened pressures of even 10,000 psi. But stronger casings, and techniques developed by Union in dealing with ever higher pressures in the Lake Arthur Field, had made "2 Elue Roach" a producing reality.

It took a lot of doing—a lot of programing and qualifying of materials—to bring in the Roach Well and the new era it foretells. So it is not surprising to see a Marsh Gauge at the top of the Christmas Tree.

Yes, wherever oil flows Marsh is at the top of the list. In the Mastergauge everything that can contribute to gauge accuracy and dependability has been brought to a higher stage of development:

- —One-piece leak-proof construction of socket, tube and tip by the exclusive Marsh "Conoweld" process.
- —Sturdy "Marshalloy" case of boiler-plate thickness steel; copper clad inside and out.
- —Precision movement with unduplicated plus features like the "coined" sector gear.
- —Stainless tubes and sockets available for any corrosive service.
- —Finally, the famous Marsh "Recalibrator" to keep the gauge always accurate.

Ask for new catalog covering Marsh instruments.



An interesting account of the method of completing the "2 Elue Roach" will be found in the February 11 issue of Oil & Gas Journal. Depth of well is 15,461 ft. Well tested 190 bbl. of condensate and 6,375,000 cu. ft. of gas daily.

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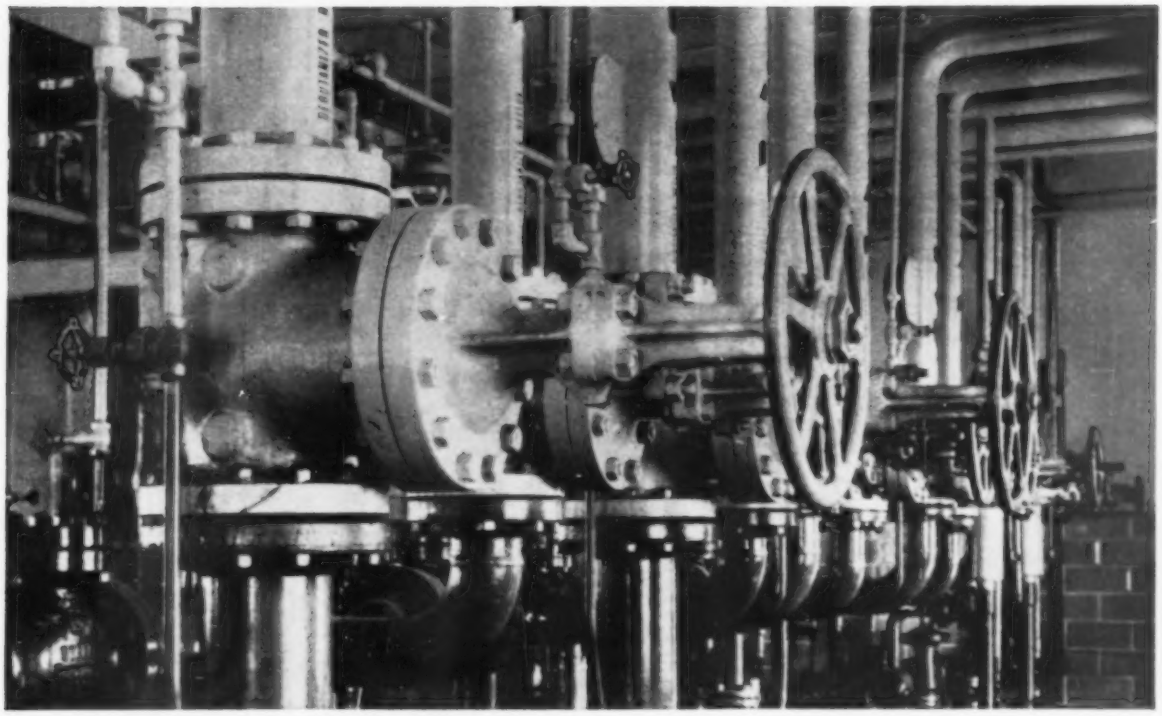

LUNKENHEIMER QUALITY is no longer a luxury—it's your vitally needed insurance against today's sky-high maintenance expense. Labor rates are going still higher . . . "downtime" costs are multiplying . . . repair charges are rocketing up—with no relief in sight. Today, it pays to buy the *best valves you can get*, with no hedging on quality. Your purchase of Lunkenheimer Steel Valves is an investment that pays worthwhile dividends in maintenance savings . . . year after trouble-free year. The Lunkenheimer Company, Box 360, Annex Station, Cincinnati 14, Ohio.

The cost of a LUNKENHEIMER VALVE
Gets smaller...and smaller...and smaller...
with each passing year of dependable service

A check on the cost of maintaining your cast steel valves will prove this point.

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PIPELINER WINS THE BATTLE OF THE MOJAVE DESERT

Unexpected rock. High winds. Rivers. Mountains. Sand. R. H. Fulton overcame them all with the help of its Caterpillar spread.

NEW CATERPILLAR NO. 572 PIPELAYER, left, teams up with No. 583 and the MDW8, lowering in on the Mojave Desert. The new No. 572 has a capacity of 86,000 pounds with a 19-inch ground clearance and 86-inch track gauge to give stability.

D9 WITH KELLY RIPPER (left) prerips unexpected rocky soil for ditcher. The Cleveland Ditcher (right) which follows is powered by a dependable Cat D339 Engine. The ditcher is cutting a depth of 65 inches at about 28 feet per minute.

NATURE put R. H. Fulton & Co. to the test during a 241-mile natural gas pipeline job across the Mojave Desert from Needles to Newhall, Calif.

Rock cropped up unexpectedly. Unseasonable high winds held up welding and painting, at times backfilled the ditch. Sand made maintenance of a firm ditch difficult. There were three river crossings and rugged mountainous terrain. But Fulton, with the help of its big Caterpillar spreads, overcame each obstacle, lowering in an average of 5,000 to 6,000 feet a day with a one-day high of 16,000 feet.

The 30-inch line is part of a $33.5 million joint expansion program of Southern California and Southern Counties Gas Companies. It will provide an additional 227.6 million cubic feet of gas per day.

Here are some of the problems Fulton encountered and how they were overcome:

ROCK—This occurred in stretches of presumably sandy material from 9 to 24 inches below the surface. By using huge Kelly Rippers mounted on the giants of the spread—CAT* D9 Tractors—a great deal of shooting was eliminated. The D9-Kelly Ripper combination prerripped the rocky soil for the ditcher.

Because of danger of rock damage to pipe in backfilling, the entire length is padded on the bottom of the ditch and top of the pipe. Two Cat No. 977 Traxcavators* and a Crosse Ditch Padder side-mounted on a D8 were used for the padding operation. A D7, working with a No. 12 Motor Grader, backfilled.

WIND—Unseasonable high winds backfilled the ditch and periodically stopped welding and painting operation. But welding crews set a brisk pace in spite of the winds. Using Caterpillar* Twin Arc-Welders on Athey track wagons pulled by a D7, their best day was 16,200 feet.

MOUNTAINOUS TERRAIN—Rugged Kane Springs Canyon and the Ord Mountains had to be crossed. A D8 and D9 were used to winch a Northwest Backhoe over the steep canyon grade. Later, D9s towed stringing trucks in and out of the mountainous area.

Altogether, Fulton had almost 70 Caterpillar track-type Tractors and Pipelayers at work. In addition there were five Twin Arc-Welders, and dependable Caterpillar Diesel Engines powered cranes, backhoes and ditchers.

When it comes to the tough jobs, pipeliners know there is only one make of equipment designed to produce wherever the pipe takes them. That's why the standard color in fast-moving spreads throughout the world is Caterpillar yellow.

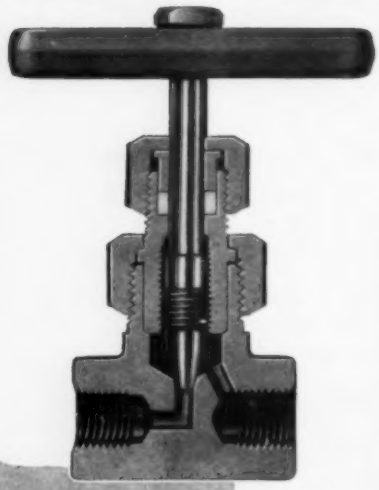
CAT TWIN ARC-WELDERS, mounted on Athey track wagons and pulled by a D7, helped make up for time lost due to high winds in the desert. Best day: 16,200 feet.

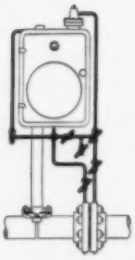
CATERPILLAR TRACTOR CO., PEORIA, ILLINOIS, U. S. A.

*Caterpillar, Cat and Traxcavator are Registered Trademarks of Caterpillar Tractor Co.

For corrosive field service...

AMERICAN® Needle Valves





Teflon-packed, forged steel American® Needle Valves stand up in the toughest meter manifold jobs and other corrosive field services without gland leaks. Stainless or carbon steel precision machined valve bodies are specially suited for welding. Stainless steel centerless-ground valve stems are designed so that the valve can be repacked under pressure.

Standard valves design rated for pressures to 5,000 psi at 70°F. For pressures to 10,000 psi, upon request, valves are hydrostatically tested and individually inspected. Valves are furnished with graphite-impregnated asbestos packing for temperatures above 450°F.

Angle or straight patterns —screwed or union bonnets.

Consult your American Meter representative for full details.

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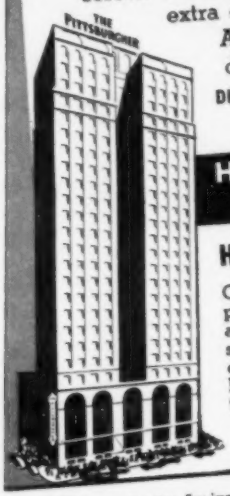

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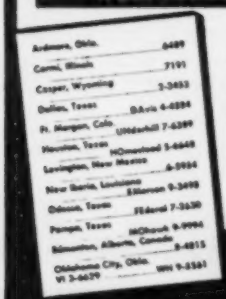
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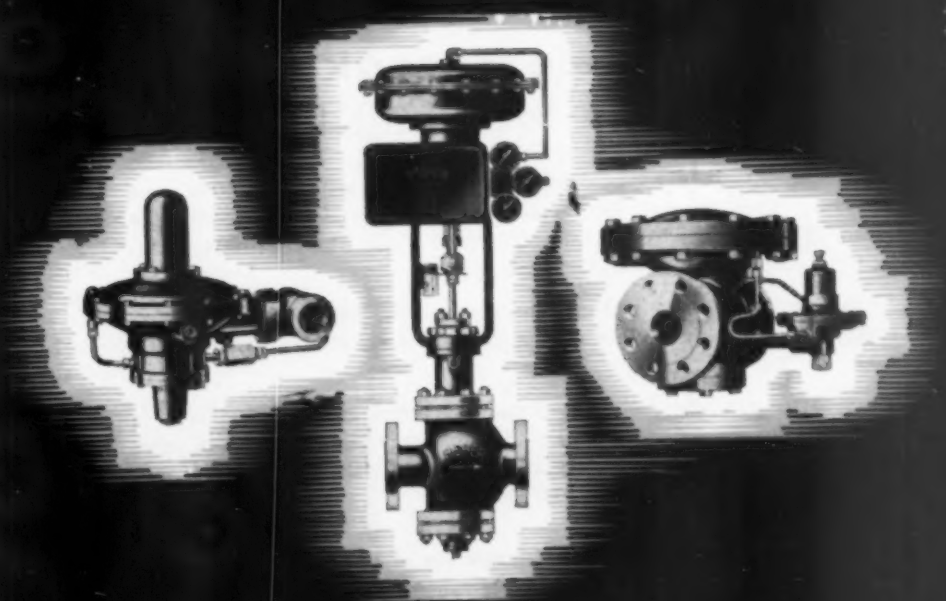

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Thredkote 701 is a top-quality thread lubricant containing 60% pure metallic zinc. When the tool joint is madeup tight, this zinc is deposited on the threads in a thin film. As the string is run, this zinc film effectively guards against metal-to-metal contact and prevents galling.

Thredkote 701 gives the tool joint threads superior lubrication, so the joints will makeup easy and tight. It seals against high pressures, yet permits ready break-out.

Be sure to give new tool joint threads a careful and complete coat of Thredkote 701 for the first four or five trips that they make. New tool joints need this extra lubrication and protection because they resist makeup more than old ones, and their threads are more likely to gall.

Thredkote 701 is one of a complete line of Humble thread compounds. There's one for almost every type of threaded connection. For more information on Thredkote, call your nearest Humble wholesale plant, or write or phone:

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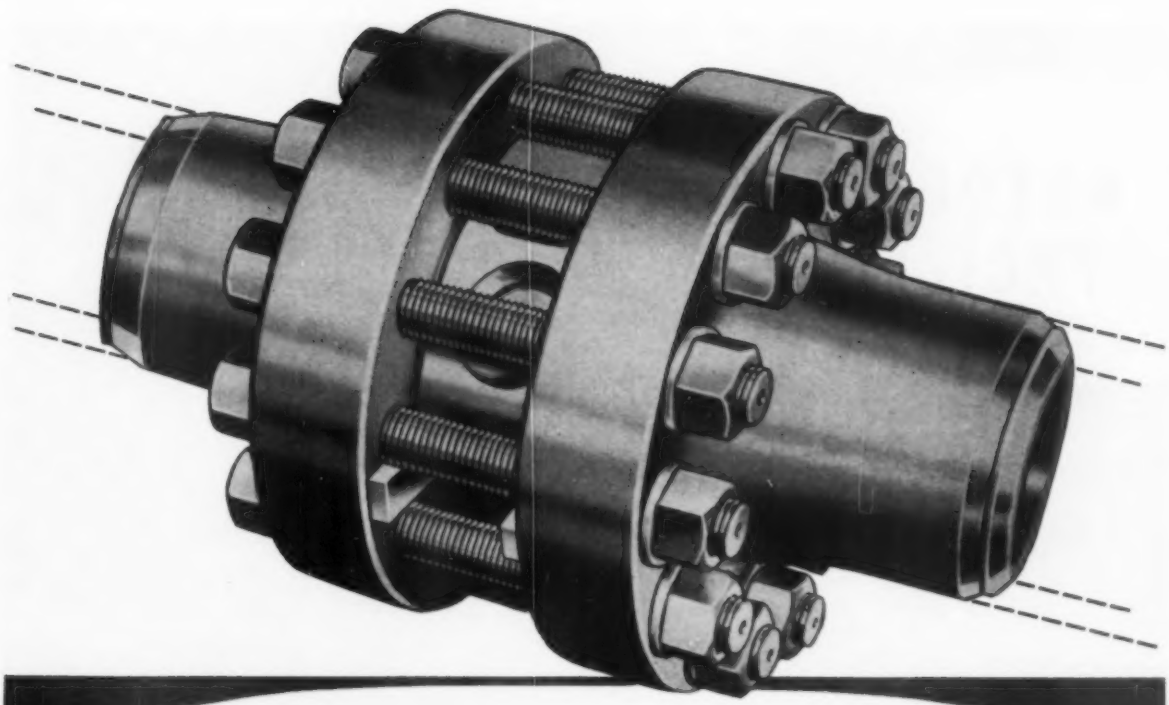

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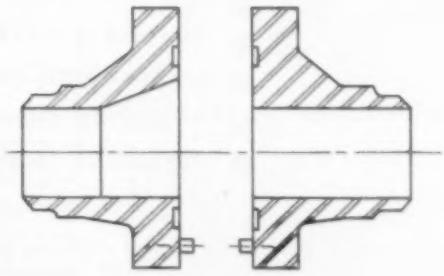
Tilting Disc Check Valve

When and if the time comes, it's as simple as this. You remove the studs between inlet and outlet section. You slip out the whole center . . . the working section . . . as a unit. You repair it or replace it and you have a valve as good as new in almost no time. It's the quickest, *lowest-cost* fix in valves.

Of course, with this 3-piece valve you get all the exclusive advantages of the Chapman 2-piece Tilting Disc Check Valve. You get fast, quiet operation. No flutter. No slamming. No banging. You get no scraping or wear and tear on disc or seat. You protect your whole valve system and keep your maintenance low.

If you don't have complete information on this and other Chapman Tilting Disc Check Valves, write for it, today. We'll get it into your hands, fast.

. . . just remove the center section



The Chapman Valve Manufacturing Co.

INDIAN ORCHARD, MASS.

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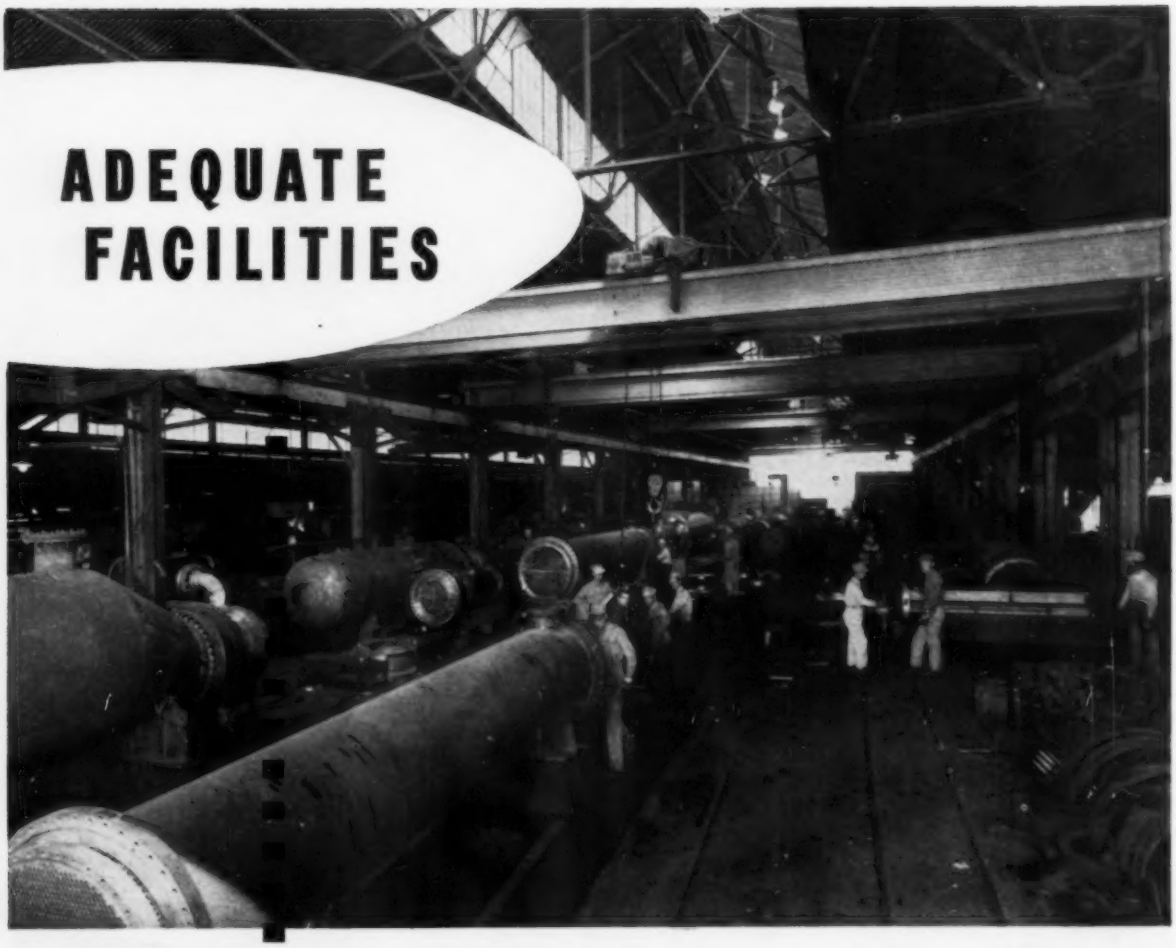

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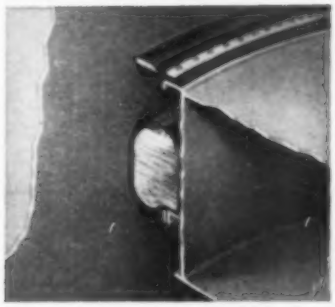
USE HAMMOND TUBESEAL* FLOATING ROOFS!

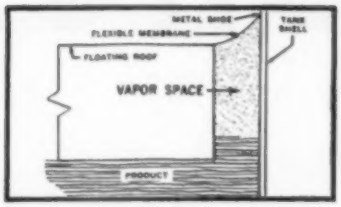


TUBESEALS are made lightning-proof with their exclusive electric conductor weather seal.[1] This specially compounded synthetic rubber, extending continuously around the entire perimeter, between roof and tank shell, provides an infinite number of contact points. ELABORATE TESTING by an independent laboratory[2] discloses that the seal prevents isolation and collection of static electricity charges, providing a continuous conductive surface with large current carrying capacity. Induced charges from lightning are immediately dissipated and fires are prevented. There are no mechanical contacts to cause sparking.

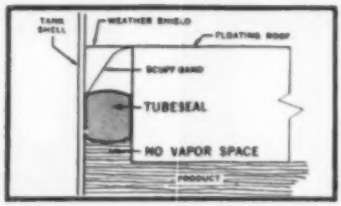
WITHOUT VAPOR THERE CAN BE NO FIRES . . . the inherent design and construction of Hammond Tubeseals eliminates space between roof, shell, and liquid; thus, there is no room for vapor to form . . . no vapor . . . no fires . . . no evaporation . . . no corrosion!

Introduced to the oil industry late in 1955, the Hammond Tubeseal found immediate favor with oil companies all over the world . . . there are now more than 200 installations in operation and building. A measure of their conservation values and fireproof features is illustrated by their record of repeat orders from satisfied users—one large oil company, after several test installations, re-ordered more than a score of Tubeseals. The same story of satisfaction exists wherever a Tubeseal is in operation.

Write for bulletin TS



CONVENTIONAL FLOATING ROOF tank has space below flexible membrane where air-vapor mixtures form. Because metal shoe and membrane cannot be absolutely gas tight, vapor is constantly escaping. This condition causes excessive corrosion, may also result in rim fires from lightning or other source.



HAMMOND TUBESEAL FLOATING ROOF entirely eliminates every space where air-vapor mixtures can form. Hammond Tubeseal completely fills space between product surface and roof seal, so that corrosion is stopped (even for sour crudes), and vapor cannot form—hence cannot ignite or be lost.

THE HAMMOND TUBESEAL
for new or old floating roof tanks,

FEATURES

- **lightning and fire proof construction**
- **no moving parts**
- **no mechanical maintenance**
- **climate-proof**
- **non-corrodible**
- **can operate to bottom of tank or above the top**
- **no vapor space below the seal**
- **entire circumference has tight seal under pressure at all times**
- **longer working life expectancy**

*Patented [1]patent pending [2]names on request

HAMMOND TUBESEAL — THE MOST EFFICIENT AND POSITIVE SEAL KNOWN

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For the engineer and scientist, with a minimum of instruction, the compact new IBM 610 Auto-Point Computer provides large-scale electronic computer facilities at desk-side.

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A FLOATING ROOF IS ONLY AS SAFE AS ITS SEAL

SAFER

SAFER BECAUSE the design of the seal virtually eliminates critical vapor space—prevents collection of explosive air-vapor mixture, even in the broad range of jet fuels.

SAFER BECAUSE even in exposure fires if fabric is damaged, there is an all-steel, fire-retardant seal. In exposure fires, all-fabric seals burn out quickly, leaving no seal at all.

SAFER BECAUSE the fabric is protected by the Weather Hood against sun and the collection of rust and ice. Fabric never comes in contact with the tank shell and can be inspected easily at any time.

SAFER BECAUSE the floating roof is "grounded" to the tank by an electrical path which never passes through a confined air-vapor volume.

SAFER BECAUSE if boiling liquid due to external fire forces vapor up through shoe-shell slot, ignited vapor is confined to a small sector. If unburned liquid is forced up, the Weather Hood prevents it from falling back onto the fabric.

SAFER BECAUSE the possibility of fire originating within the seal is reduced almost to zero. Even when the air-vapor mixture is test-ignited, pressure during burning is held to atmospheric. Fabric *instantly* flexes upward—expanding 300% to 500%—containing the products of combustion without damage to the fabric.

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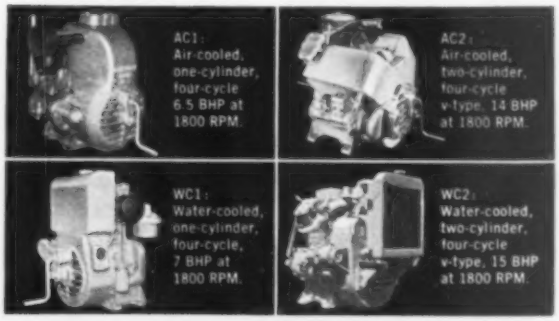
for progressive crude oil pipe line company operating throughout Oklahoma. Pipe line experience desirable. Must be graduate and have knowledge of latest electrical apparatus, automatic controls, remote control communication equipment; electronic devices. Liberal company benefits. Address all replies, giving age, education, resume of experience and salary expected to Employee Relations Department, P. O. Box 381, Tulsa, Oklahoma. **Replies will be kept confidential.**

THE BIG 4 IN DIESEL POWER

AMERICAN MARC Inc. dominates the field of lightweight, low-horsepower Diesels by building its diversified line from the "Big Four" basic models illustrated here. Purchase and maintenance of engines and parts are simplified by the use of these compact and rugged prime movers.



AC1: Air-cooled, one-cylinder, four-cycle 6.5 BHP at 1800 RPM.

AC2: Air-cooled, two-cylinder, four-cycle v-type, 14 BHP at 1800 RPM.

WC1: Water-cooled, one-cylinder, four-cycle, 7 BHP at 1800 RPM.

WC2: Water-cooled, two-cylinder, four-cycle v-type, 15 BHP at 1800 RPM.

AMERICAN MARC also manufactures Diesel generating plants from 3 to 10 KW (AC or DC, and industrial three-phase), Diesel pumping units from 48 to 1700 GPM, marine propulsion, refrigeration units and power-packages for other services. American MARC can adapt any of its Big 4 engines to fit every job requiring from 5 to 20 BHP.

INQUIRIES ARE INVITED FROM DISTRIBUTORS AND DEALERS

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MAKES FOR Safety

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Good Equipment and safety to both crew and well go hand in hand.
Franks Rocket provides fastest rig-up and operation with maximum of safety.
Speed is in the design, so there's no straining to do a fast job.
Rig-up is faster with a telescoping derrick that moves strung-up, raises hydraulically, is simple to level, and guys to the unit.
The air lift transfer provides speed in pulling, and stacking affords protection to rods and tubing. See a Franks representative or write for details on the various Rocket models 6,500 to 12,000 ft.

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This 240,000-pound steam drum, built by Combustion Engineering for a large generating plant, is here being hoisted 120 feet into position by strong wire rope. It's a striking example of how . . .

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You may never hoist loads as large as this 120-ton drum. But *safe, top quality wire rope is just as important to your own operations.* For, although the price of a "bargain" rope would be less, failure of such a rope could cost you thousands of dollars in wrecked equipment. Don't be a victim of false economy. Buy a wire rope that's a quality rope—buy Wickwire Rope.

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Of Things To Come . . . In Oil

INCREASED OIL EXPLORATION IN ALASKA is virtually assured by passage of a bill giving the territory title to tidelands adjacent to surveyed town sites. Awarding of mineral rights was made with the stipulation that they must always be retained by the territory. This may be considered another step toward opening Alaskan areas, largely held by the U. S. Government, to the drill.

$115 BILLION WILL BE NEEDED between now and 1965 to supply oil needs of the U. S. and the Free World, estimates R. L. Heilbronner in a recent API Quarterly article. Daily domestic oil consumption in 1966 is expected to be 14.3 million bbl daily. By 1975, says the economist, an investment of $200 billion in the industry will be needed to supply the Free World with a 27 million bbl per day demand.

EFFECT OF IMPORTS ON FUTURE U. S. DRILLING will be closely watched in coming months as a key to effectiveness of the new voluntary import curb program. Government officials may well parallel rate of increase in domestic drilling to efforts to build U. S. oil reserves. These officials, who are worried over Syrian turn of events, say they won't forget the Suez crisis — and domestic producer organizations say they won't let the government forget it, either.

MORE MISCIBLE FLOOD TYPE PROJECTS can be expected, particularly in the Southwest. Research is going ahead at full speed, and several companies admit specific studies of individual fields are well underway. This new oil recovery method looks exceptionally good, in the face of increasing costs to find new oil. Only cloud on the horizon is the availability and cost of solvents such as LPG — butane in particular.

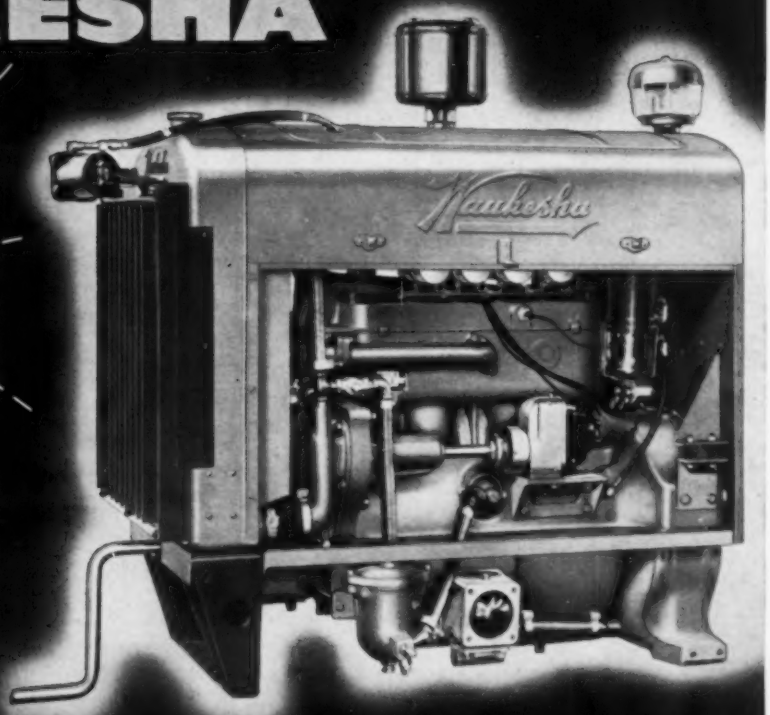
CANADIAN DRILLING ACTIVITY will accelerate some this fall, but should really get going after the spring thaws. More and more contractors are being asked to take rigs to the North country where several major discoveries have been made this year, and leasing activity has been high. Rig availability is a big problem in some areas now . . . and may be more critical in 1958.

NEW HOPES FOR INDEPENDENT GAS PRODUCERS rise in a new federal case now before a Federal Court of Appeals in Denver. Test case involves Saturn Oil and Gas Company, a small Kansas producer, and the FPC. Producer associations representing every producing area in the nation, claim this is the first such case involving a "true" independent entangled in federal control of gas at the wellhead. Should Saturn win, the Phillips case ruling would be usurped — and would necessitate new action by the U. S. Supreme Court.

WAUKESHA

LONG LIFE

OIL FIELD POWER UNITS



Typical Long-Life Utility Unit—Model XAHU

Continuous Duty Power—for long periods *without servicing*

The *Long-Life* oil field Waukeshas are special gas power units—with additional features and accessories built right in. That's why they operate without any of the usual routine maintenance and attention. Now, the inspections needed are few and far between.

Just give these *Long-Life* units a regular and uninterrupted fuel supply, and you'll make considerable savings—in pumping and compressor service for oil and gas pipe line feeder operation, and similar uses.

Basically these *Long-Life* power units have the standard gas engines—long famous for being rugged and reliable—that have made Waukesha the world's finest oil field power.

On these basic engines Waukesha assembles the many *Long-Life* design-specials including specially lubricated clutches; automatic oil levelizers; low tension magnetos, with individual coil, low wear spark plugs; special fan belts, and water stabilizing filters; water condensers, and automatic radiator shutters. You'll want details on all *Long-Life* features.

Send for descriptive bulletin 1702.

LONG-LIFE CONTINUOUS DUTY NATURAL GAS UNITS					RECOMMENDED 65% HP RATINGS				
Model	Features*	Bore & Stroke	Displ.	Speed (rpm) →	800	1000	1200	1400	1500
FCU	4-Ir	3¼ x 4	133	CONTINUOUS DUTY ratings shown are 65% of maximum hp available at indicated speeds →	7	9	11	13	14
XAHU	4-Ir	3⅜ x 4½	186		10	14	17	20	21
190-GLBU	6-A	3¾ x 4	265		19	23	27	31	32
195-GKU	6-A	4⅛ x 4	320		20	25	31	36	38
135-GKU	6-A	4¼ x 5	426		28	34	41	47	50
140-GZU	6-A	4⅜ x 5½	554		42	52	62	71	.....
145-GZU	6-A	5⅜ x 6	817		62	77	90	103	.....
WAKU	6-A	6¼ x 6½	1197		84	114	124	.....	.....

*Features: 4, 6—No. Cylinders; A—Aluminum Pistons; Ir—Cast Iron Pistons

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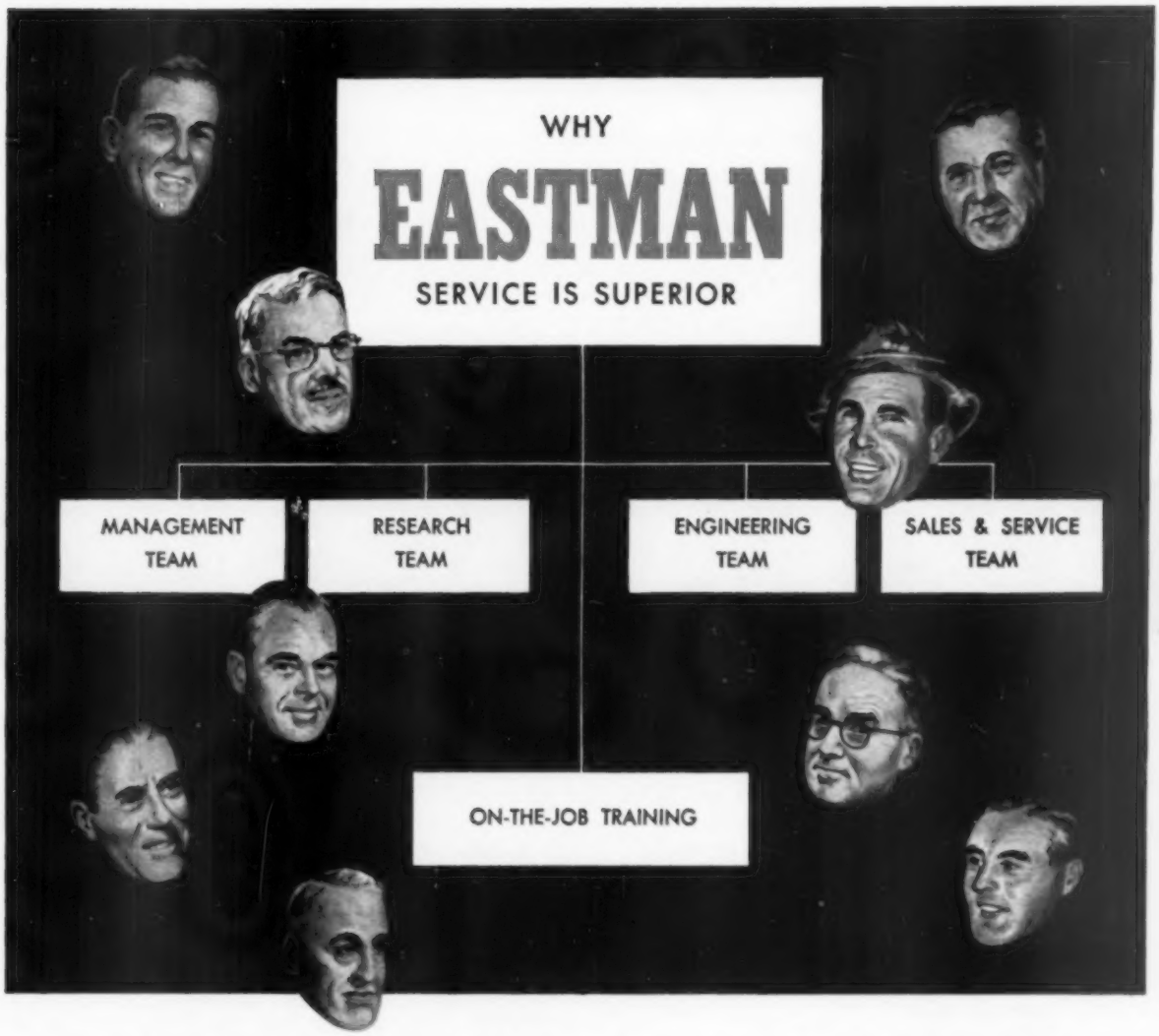

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No. 2 advertisement of six proving . . .

why Jones sucker rods last longer

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6. *Advanced Field Engineering and Service*

There is a

The S. M. Jones Company ADVANCED ENGINEERING, EXPERIMENTATION AND CONTROL

Year after year, for over 65 years, Jones engineers have solved problem after problem and have kept Jones Sucker Rods the standard of comparison. But the policy of the Jones engineering department is never to be satisfied, never to rest on laurels already won.

To this end Jones engineers have the use of a large fund of accumulated practical knowledge gained from years of laboratory and field tests. Thus Jones customers are assured of the earliest possible use of definite improvements.

The Jones engineering department keeps a tight control throughout all operations from raw stock to the finished sucker rod. Laboratory testing for correct alloy content and physical properties, after proper heat treatment, assures Jones using only the best steel completely free of defects. Controlled normalizing and tempering results in a microstructure which is uniform throughout.

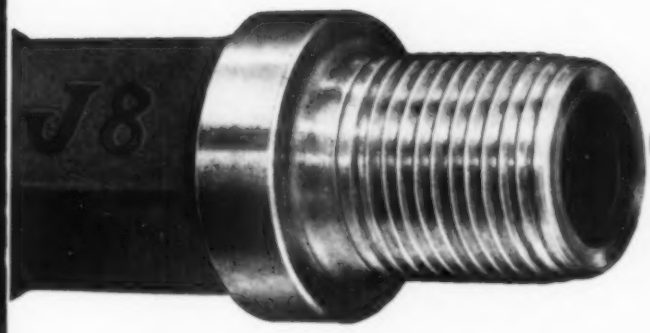
There is no substitute for Jones experience and thoroughness in engineering, experimentation, and control. The continued leadership of Jones Sucker Rods is proof of that.

Above: All A.P.I. working gages are checked daily with master A.P.I. gages which are periodically certified by the National Bureau of Standards, Division of Metrology. Control like this insures uniformity of threads.

Left: Resistance to impact of heat treated sucker rod stock and experimental alloys is studied with this Izod-Charpy impact testing machine.

PETROLEUM EQUIPMENT SUPPLIERS ASSOCIATION

difference in sucker rods



TYPE 8

JONES

alloy SUCKER RODS

For extremely heavy pumping loads.

This rod is the result of long research and field use to produce the very best rod for exceedingly heavy pumping. It is made of special alloy steel of exceptional yield strength and well-balanced physical properties.

Specify Jones Sucker Rods for proved longer life.

FOUR TYPES OF JONES SUCKER RODS FROM WHICH TO CHOOSE

Type	Identification	USE	DESCRIPTION	PHYSICAL PROPERTIES					
				Yield 1000 psi	Ultimate 1000 psi	% Elong. in 8"	% Red. of Area	Izod	Brinell Hardness
J-12	Protector ends painted BLUE	For heavy pumping loads under all conditions	Made from processed electric furnace steel with high yield strength and excellent fatigue resistance.	95-105	110-125	12-17	65-75	90-110	229-260
J-8	Protector ends painted BLACK	For extremely heavy pumping loads	A special alloy steel of exceptional yield strength and well-balanced physical properties.	100-115	120-135	10-15	50-60	65-85	240-260
J-7	Protector ends painted ORANGE	For medium to heavy pumping loads under all conditions	Called "standard of the industry". Strong, corrosion resistant nickle molybdenum steel, fully normalized, tempered, descaled and shot peened for further fatigue and corrosion resistance.	85-80	85-100	14-22	60-70	90-107	170-210
J-2	Protector ends painted WHITE	For medium to heavy pumping loads in non-corrosive fluids	High grade carbon manganese steel, fully normalized, descaled and shot peened to add strength and endurance.	60-75	90-105	18-24	60-70	60-90	160-210

Jones Pony Rods carry the same physicals as Jones Sucker Rods. Always use proved superior Jones Pony Rods with proved superior Jones Sucker Rods.

THE S. M. JONES COMPANY

●

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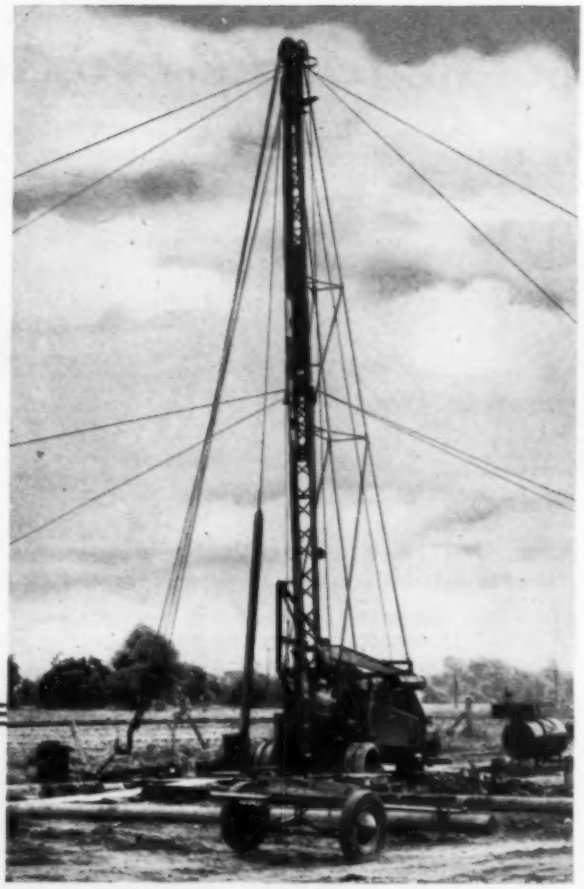
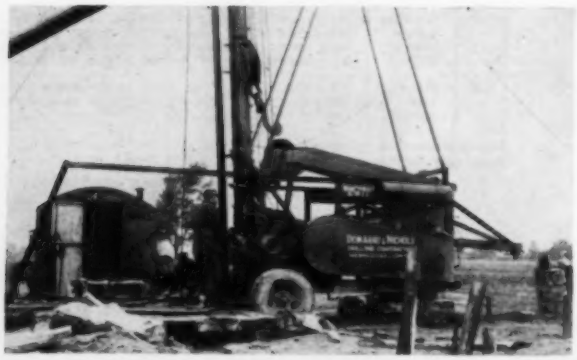


● ***SHALLOW DRILLING IN RODNEY FIELD*** — John Palenkas, drilling contractor, of Highgate, Ontario, uses a Bucyrus-Erie 60-L to advantage in a shallow oil field near Rodney.

● ***TOP-TO-BOTTOM OIL WELL IN ALBERTA*** — This 48-L, equipped with a 150-ton capacity Tripod Derrick, drills for oil near Odin, Alberta. The rig is owned jointly by Robert Pattie and Boyd Stewart of Cut Bank, Montana.



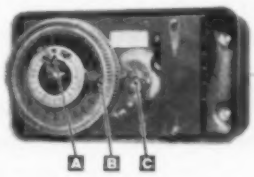
● ***RUNNING SWAB IN ONTARIO*** — Clarence Demaray of Demaray & Nichols, Drilling Contractors, of Kerwood, Ontario, uses a 60-L to run a swab near the 425-ft. completion depth.

Rugged... Dependable... Completely Automatic...

CUTLER-HAMMER THREE-STAR OIL WELL PUMPING CONTROL is the overwhelming choice of oil field engineers everywhere. No other control is as rugged . . . Cutler-Hammer control is immune to blistering heat, to choking dust, to driving rain, sleet and snow. No other control is as dependable . . . Cutler-Hammer control, featuring vertical dust-safe contacts, can be relied upon to pump your wells *indefinitely* without attention as far as the electrical equipment is concerned. No other control is as completely automatic . . . the Cutler-Hammer Supertimer has made oil well pumping by *automation* a reality.

For your next pumping well, insist on Cutler-Hammer Three-Star Oil Well Pumping Control. No other control offers as many outstanding features: exclusive Cutler-Hammer Supertimer—Three-Star magnetic contactor with vertical dust-safe contacts—aluminized, chimney draft-design enclosure—vertical contact contactor type disconnect switch—advanced-design lightning arresters—full three-phase, three coil overload relay—selector switch for automatic or manual operation—dead phase protection—double door isolation of live parts—undervoltage release relay—spring-clip type fuse receiver—removable steel component base plate—padlock features for outer door, inner door, and Supertimer.

Your nearby Authorized Cutler-Hammer Distributor is stocked and ready to serve your needs. Order from him today. CUTLER-HAMMER, Inc., 1459 St. Paul Ave., Milwaukee 1, Wisconsin. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ontario.



NEW CUTLER-HAMMER Supertimer

This is automation in action. You pre-set the Supertimer to meet your field allowable and the control will do the rest, automatically. It starts, stops, restarts and cycles indefinitely, precisely according to your schedule. If a power outage occurs, any number of C-H controlled pumps are automatically restarted in an exact sequence to avoid overloading the power lines on inrush. Unfortunate coincidental starting of even two pumps is impossible.

- **A** Sets the precise restarting time delay from zero to 180 seconds. This is exclusive with the Supertimer—unfortunate coincidental starts of even two pumps are impossible.
- **B** Sets the daily pumping schedule—pull a tab for each fifteen minutes of pumping, space them through the daily 24 hour period as desired.
- **C** Sets the weekly pumping schedule—1, 2, 3, 4, 5, 6 or 7 days per week as desired.

CUTLER-HAMMER
MOTOR CONTROL
C-H

Member American Petroleum Institute

COMPLETE PROTECTION. The control is protected against lightning with exclusive, advanced-designed lightning arresters; and the three coil overload relay protects the pump motor from overloading and dangerous single phasing which often results from lightning.

CHIMNEY DRAFT VENTILATION. The heat-reflecting, aluminized enclosure insures a constant circulation of air . . . no nuisance tripping because of trapped heat.

DUST-SAFE CONTACTS. Dust-Safe vertical contacts stay clean and eliminate the necessity of contact replacement.

NOW

Dorrco D-Sander Available in Three Standard Sizes . . .

Mud Capacity
(at 20 psi operating pressure)

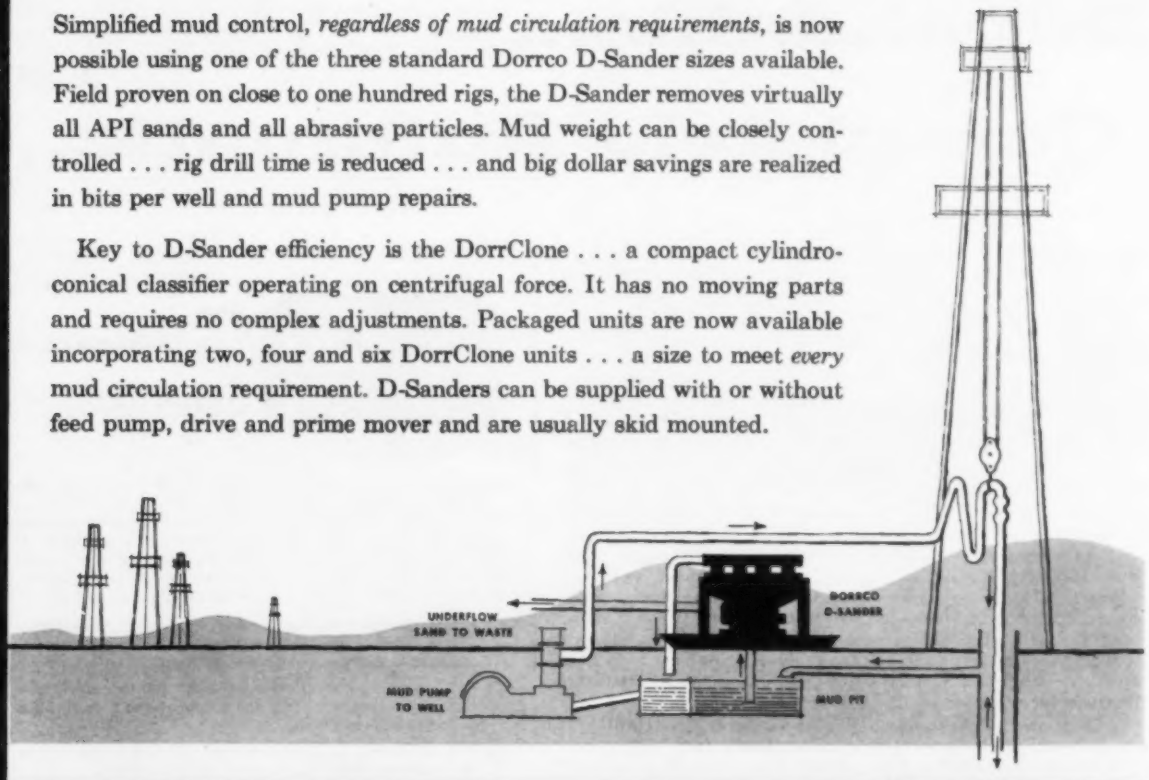
#2 D-Sander — 200-250 gpm

#4 D-Sander — 400-500 gpm

#6 D-Sander — 600-800 gpm

Simplified mud control, *regardless of mud circulation requirements*, is now possible using one of the three standard Dorrco D-Sander sizes available. Field proven on close to one hundred rigs, the D-Sander removes virtually all API sands and all abrasive particles. Mud weight can be closely controlled . . . rig drill time is reduced . . . and big dollar savings are realized in bits per well and mud pump repairs.

Key to D-Sander efficiency is the DorrClone . . . a compact cylindro-conical classifier operating on centrifugal force. It has no moving parts and requires no complex adjustments. Packaged units are now available incorporating two, four and six DorrClone units . . . a size to meet *every* mud circulation requirement. D-Sanders can be supplied with or without feed pump, drive and prime mover and are usually skid mounted.



For more information on the Dorrco D-Sander, contact our U. S. Sales Representative, Salt Water Control Inc., 1211 Fort Worth National Bank Building, Fort Worth 2, Texas.

D-Sander T.M. Reg. U.S. Pat. Off.

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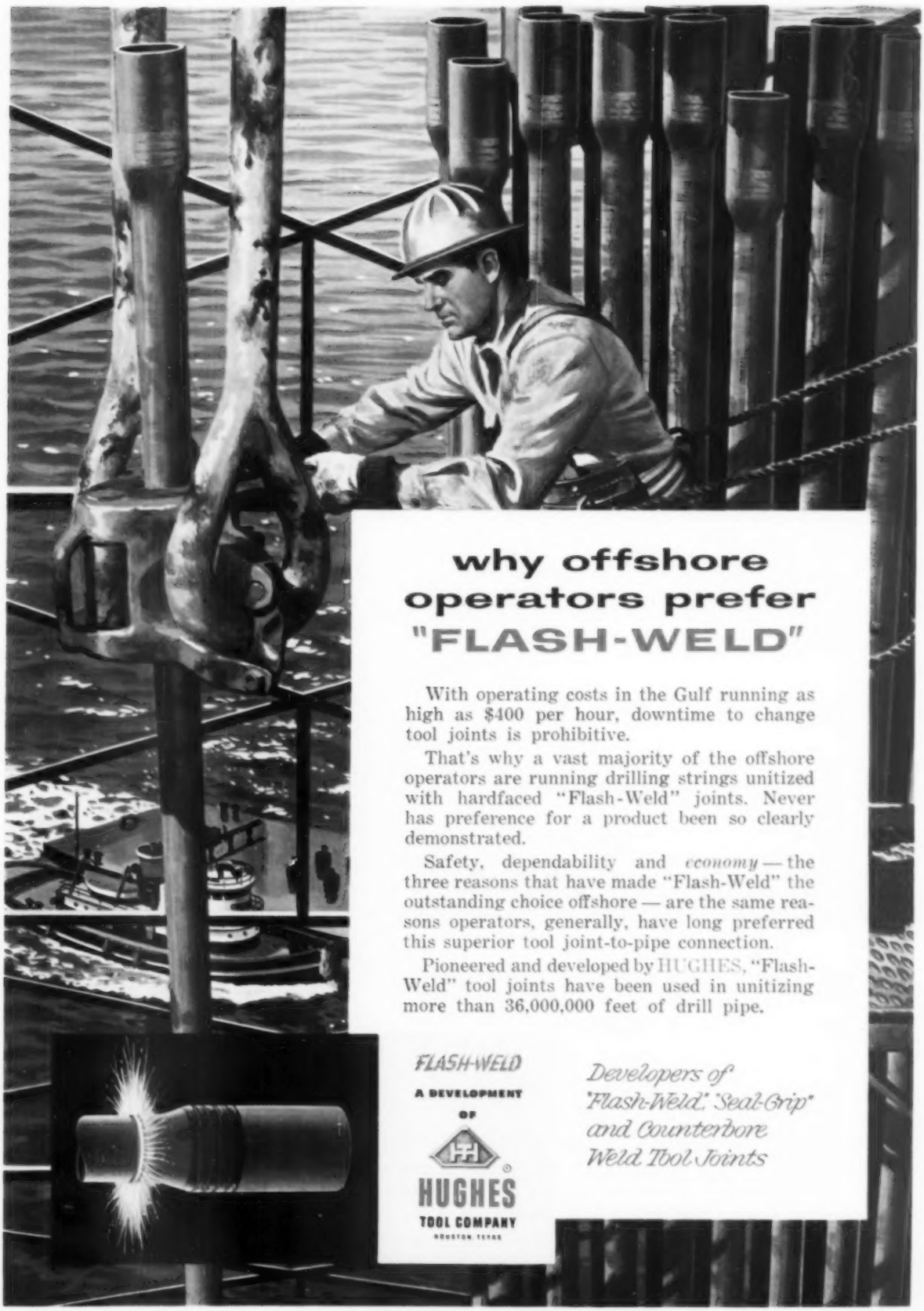


why offshore operators prefer "FLASH-WELD"

With operating costs in the Gulf running as high as $400 per hour, downtime to change tool joints is prohibitive.

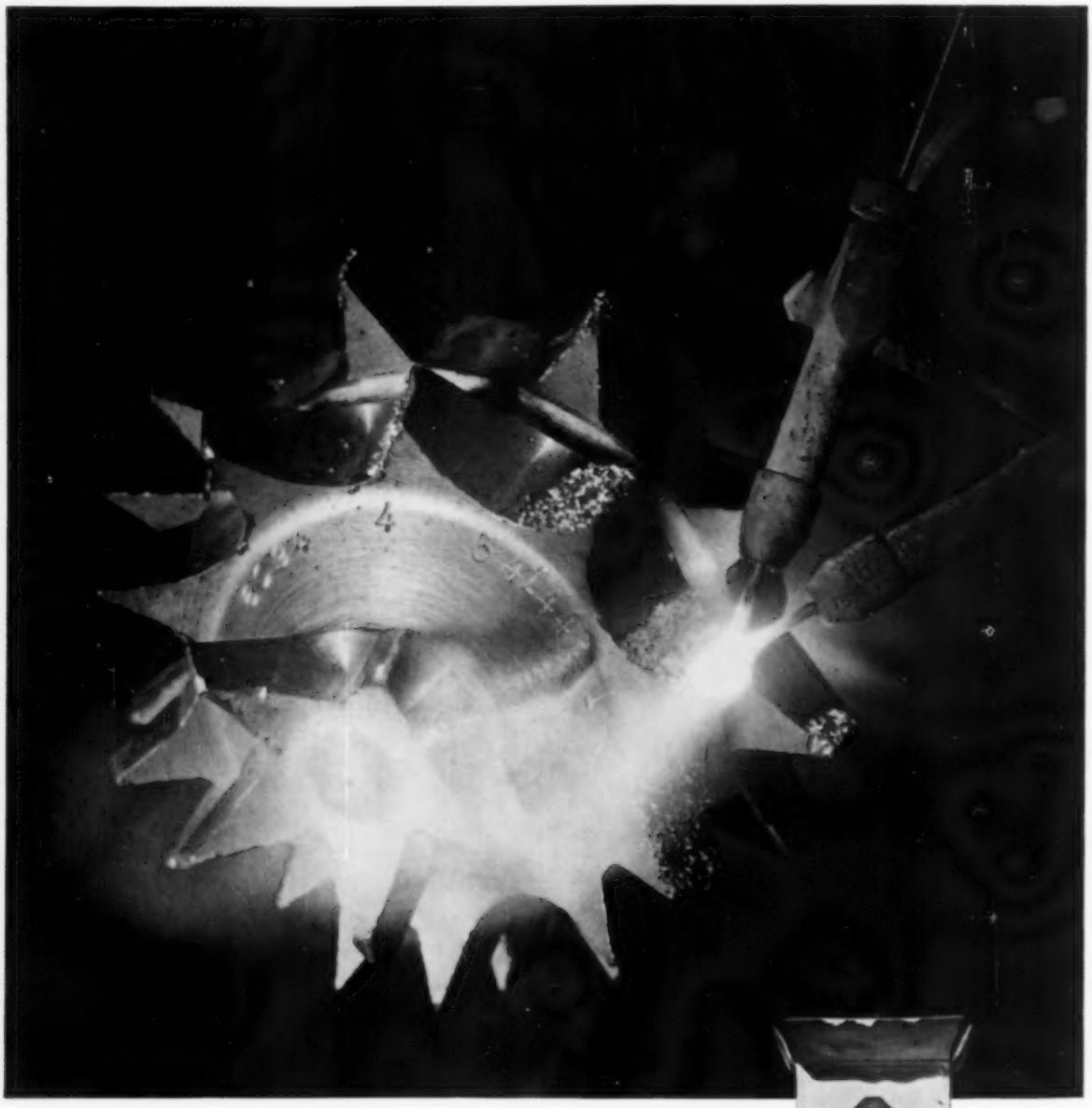
That's why a vast majority of the offshore operators are running drilling strings unitized with hardfaced "Flash-Weld" joints. Never has preference for a product been so clearly demonstrated.

Safety, dependability and *economy* — the three reasons that have made "Flash-Weld" the outstanding choice offshore — are the same reasons operators, generally, have long preferred this superior tool joint-to-pipe connection.

Pioneered and developed by HUGHES, "Flash-Weld" tool joints have been used in unitizing more than 36,000,000 feet of drill pipe.

FLASH-WELD
A DEVELOPMENT
OF
HUGHES
TOOL COMPANY
HOUSTON, TEXAS

Developers of "Flash-Weld", "Seal-Grip" and Counterbore Weld Tool Joints



HARDFACING

when and where it's needed!

— another reason you make hole faster with Hughes Rock Bits

How and where hardfacing is applied is as important as the hardfacing material itself.

In getting the facts to determine the *best* application and placement of hardfacing, over one hundred thousand rock bits are examined in the field and the laboratory each year.

The combination of experience, our own superior hardfacing (Hughesite) and the knowledge of just where and how to apply it, is still another reason why HUGHES rock bits can be depended upon to deliver consistent, dependable performance, time-after-time.

Applying NO-OX-ID Coating and Wrapper by Traveliner.

Mill- or yard-wrapping for long-term protection at its best.

Hand application of NO-OX-ID Cold Coating.

NO-OX-ID "C-M" Casing Filler protects casing and carrier pipe under highways and railroads.

NO-OX-ID coating-wrapper combinations are the versatile answer to every kind of pipeline protection

Whether you are installing distribution or transmission lines—whether you are working over rough or smooth terrain, there is a NO-OX-ID Coating and Wrapper Combination to give the right protection.

On mill-wrapped pipe, NO-OX-ID Coating, Wrapper and Service Coat protect from mill to ditch. NO-OX-ID can be applied over the ditch by Traveliner using less material and equipment. Hand-applied on short line installations, service lines or special fittings, NO-OX-ID goes on fast. No noxious fumes.

Leading pipeline contractors and utilities rely on versatile NO-OX-ID Coating and Wrapper Combinations. Consult with your Dearborn Pipeline Engineer. He will help you select the right combination for your next pipeline job.

New NO-OX-ID catalog

Just off the press. This 12-page illustrated catalog tells how NO-OX-ID combinations fit job requirements. Your copy is ready...USE THE COUPON.

Dearborn Chemical Company
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☐ Send my copy of the new NO-OX-ID catalog.
☐ Have a Dearborn Pipeline Engineer bring my copy.

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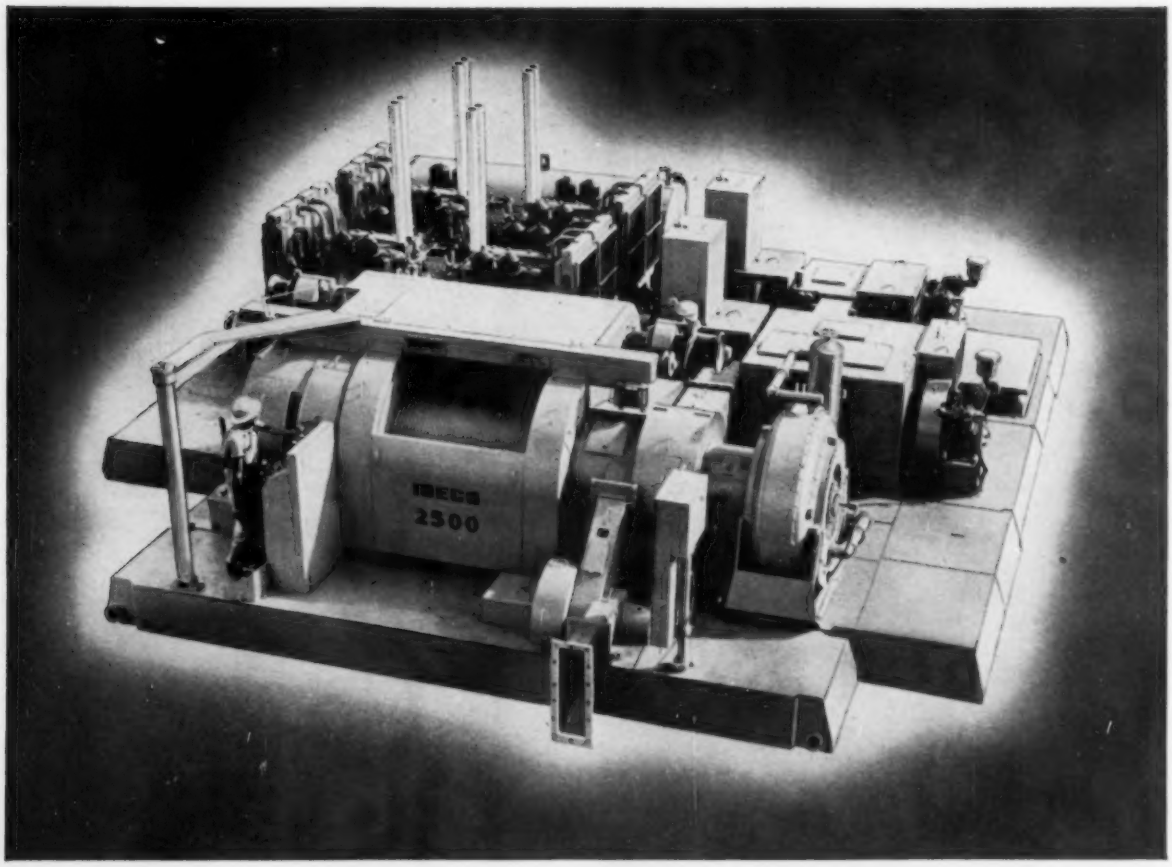
Dearborn® NO-OX-ID

Protecting Metal Against Corrosion for 70 Years



In the drawworks... REX for two reasons

You'll find Rex Roller Chains in many of the Ideco Drawworks you see around the oilfields.

Why Rex? Ideco chooses Rex for the two very fundamental qualities a roller chain must possess to qualify in oil field service. Rex Roller Chain has these qualities.

The first is, of course, maximum life. This—a combination of resistance to wear and ability to withstand fatigue—is accomplished in an always continuing program of improvement in design and manufacture.

The second basic quality is ease of handling. Rex "glide-fit" manufacture permits fast coupling and uncoupling at any link. There are no rivet heads to burn off, no smashed fingers and frayed tempers, and—most important of all—the absolute minimum of down time.

In drilling service, Rex is enduring—convenient—and profitable. See your supply store. CHAIN Belt Company, 4719 W. Greenfield Ave., Milwaukee 1, Wis.

CHAIN BELT COMPANY

Milwaukee 1, Wisconsin

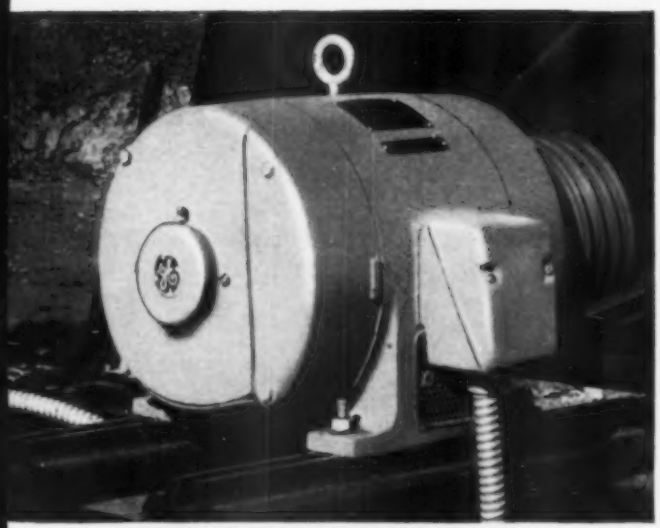
Oil Field Offices: Dallas • Houston • Los Angeles • New York
Export Offices: Milwaukee • New York

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

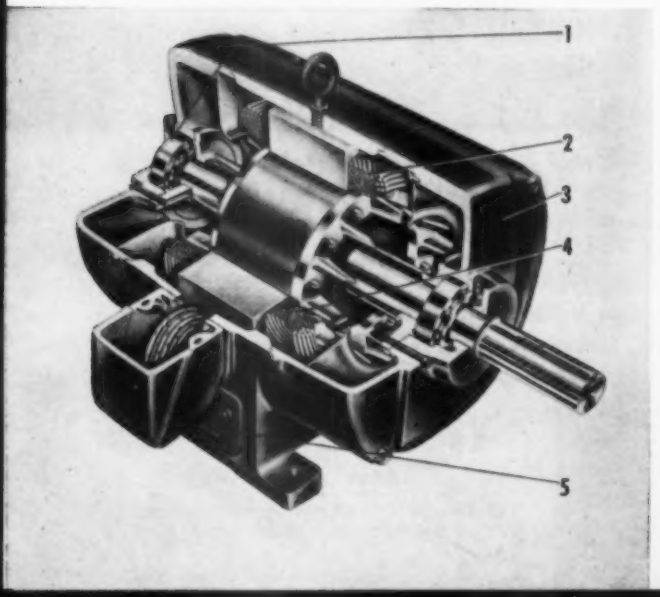
INSTALL IT... FORGET IT!

EASY-TO-MAINTAIN G-E TRI 55 CLAD MOTORS LAST LONGER

REG. U.S. PAT. OFF.



GREATER RIGIDITY AND STRENGTH of cast-iron frame and end shields prevent motor from being twisted out of line. Integrally cast ribbing on underside adds extra support.



General Electric's all-new Tri-Clad '55' oil field motor is specifically designed for long-life, easy-maintenance operation on your pumping applications. Protected against burnouts, dust and moisture, the new motor will run far longer without attention than ordinary motors.

Burnout protection for longer life—Burnouts are virtually eliminated with new Class 'B' insulation system utilizing Alkenex® heat-resistant wire enamel, and mica-glass laminate slot and phase insulation. This new system allows up to 40% higher temperature rise, yet extends motor life.

Advanced bearing system for easier maintenance—Under normal operating conditions, the advanced bearing system will operate longer without regreasing than any other motor bearing system. Effective seals on both sides of bearing housing keep grease in and dirt out, giving you all the service the long-lasting lubricant can deliver. Large grease reservoir *reduces maintenance to a few minutes every 5 years*. Pipe plugs on bearing housing permit regreasing even when motor is operating.

Greater physical protection for outdoor service—The new Tri-Clad '55' motor is built to take the weather. End shields and frame are rust-resistant cast iron. The insulation system virtually eliminates breakdown due to moisture. Air vents are protected, and removable screens guard against animal and rock damage.

Complete information available locally—For full details on the easy-to-maintain, long-life Tri-Clad '55' oil field motor, contact your local G-E motor distributor or your nearby General Electric Apparatus Sales Office. General Electric Company, Schenectady 5, N. Y. 899-1

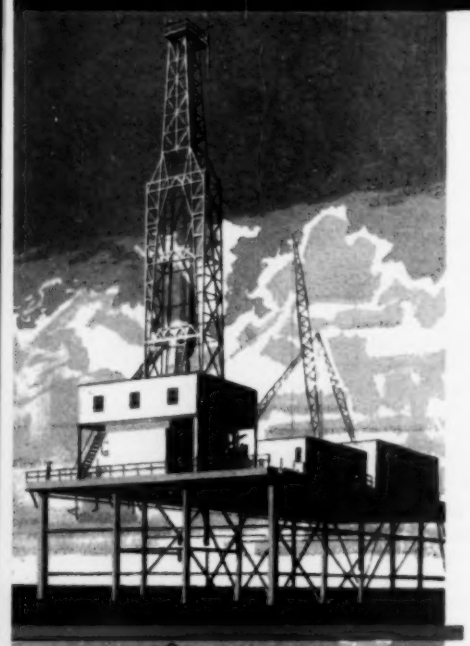
CHECK THESE YEARS-AHEAD FEATURES

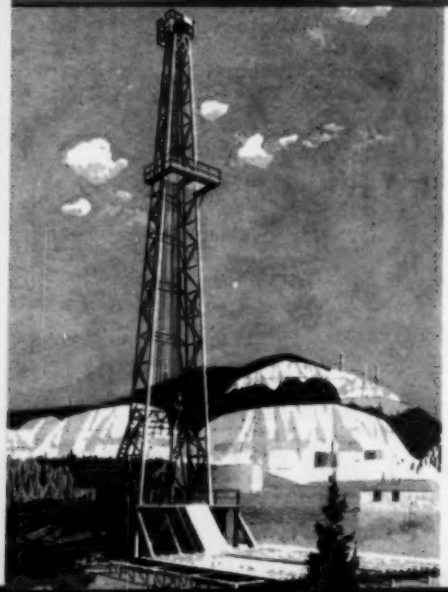
1. Advanced bearing system will last longer without regreasing than any other bearing system.
2. Water-shedding stator windings virtually eliminate breakdown due to moisture.
3. Rugged cast-iron frame helps prevent rust and accidental damage.
4. Class 'B' insulation system with revolutionary Alkenex® wire enamel allows up to 40% higher temperature rise . . . yet extends motor life.
5. Removable screens protect G-E oil field motors against damage from rodents and rocks.

Progress Is Our Most Important Product

GENERAL ELECTRIC

There's a Continental-Emsco Slush Pump rated for your rig..





From portable rigs to deep offshore installations, there's a Continental-Emsco Slush Pump that will give you the volume-and-pressure range to meet your drilling requirements. A wide selection of liner sizes allows you to step-up pressures or volumes *gradually* . or *fast*, as drilling conditions dictate.

You'll find these pumps are big in performance, low-cost in operation, and that they give you *more horsepower per pound* than any other slush pump.

A strong, rigid, lightweight power end is the result of Continental-Emsco's *Fabriform Construction*, which uses steel plates and special shapes in place of a bulky, heavy, rough casting. This means lower transportation costs and easier field handling.

Lubrication is automatic, since all running parts are flood lubricated by a positive-splash system. troublesome lubrication and grease fittings are eliminated.

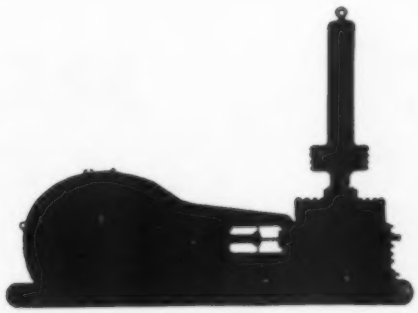
Typical of the simplified maintenance features of these pumps is their patented "exposed" liner construction. Here packing leaks can be spotted immediately . long before damage can be . or has been . done.

..for Shallow Drilling
D-175 and D-300

In the 175 and 300 horsepower range, these small pumps can produce the pressures and volumes to match the drilling range of all types of portable rigs . . and save on weight.

..for Medium-Deep Drilling
DA-500 and D-700

These pumps are designed for rigs in the 600 to 1100 horsepower class. Here are pumps sized for medium-deep drilling. They are big in capacity . . lower in weight . . yet small enough to require a minimum amount of power.



..for Deep Drilling
DA-850 and D-1000

The DA-850 at 850 hp and the D-1000 at 1000 hp are rugged pumps that can provide the pressures and volumes needed for jet-bit drilling in deep wells. Their compactness and lower weight make them perfect for offshore and barge installations where space and pounds are at a premium.

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McCullough® REPORTS TO THE OIL INDUSTRY

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New Services • • • New Tools • • • New Methods • • • Outstanding Results

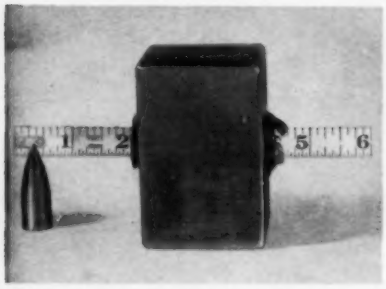

Illustration above shows a 2½" steel test sample pierced by an improved ½" Ogival Bullet fired by a McCullough M-3 Bullet Perforator.

McCullough Sectional Gun Gains Penetration Where Previous Attempt Failed

Depth of operation was only 1487' 4½" O.D. casing had been cemented in 10¾" hole. Pay zone was bullet perforated by another service company but the formation would not break down. During the attempt to fracture, the pipe split above the zone and collapsed in the perforations.

Operator swaged out the 4½" casing, ran a 3" liner inside the 4½" and cemented the annulus. This operation made an impressive amount of steel and cement to be penetrated to gain production.

McCullough shot 20 improved ⅜" Ogival Bullets in the zone and the formation broke down at 800 lbs. Time on the job was one hour. Results. a good well and a satisfied oil man.

McCullough Sectional Guns are available in 1⅛" O.D., 1¾" O.D. and 2¼" O.D. sizes.

Powerful M-3 Guns Increase Production 316%

Hard Shooting M-3 Guns, Firing Improved Ogival Bullets, Gain 38 B/D Over Previous Jet Perforating

An excellent example of the penetrating power of McCullough M-3 Bullet Guns was recently reported from a California oilfield.

This was a shallow, low production field. The well had previously been perforated by another service company with shaped charges for a settled production of 12 barrels of oil per day.

Productive interval lay between 3837' and 3872' and was cased with special 7" O.D. 51 lb. casing. Casing was cemented in 9¾" hole through the pay zone.

Although skeptical of the ability of any bullet perforator to gain effective penetration through the extra heavy casing and thick cement sheath, the operator called for McCullough M-3 Bullet Guns.

McCullough Service Crew made three runs with 4¾" O.D., 20-shot M-3 Guns, firing 140 improved ½" Ogival Bullets, four per foot, in the 35' zone.

Production increased from 12 to a settled 50 barrels of oil per day—a gain of 38 barrels. The job required two hours, including rigging up and tearing down. To quote the operator, "Results were very satisfactory and gratifying".

"world's hardest shooting bullet perforator"

M-3 Penetrates Two Strings For a Good Well

Two strings of casing had been set through the pay zone at 5587'–5590'. 5" O.D. 18 lb. liner was cemented in 7⅝" O.D. 28 lb. casing which, in turn, was cemented in 11¼" open hole.

A 3½" O.D. McCullough M-3 Gun fired 18 improved ½" Ogival Bullets in the three foot pay zone. Operator stated he is satisfied it is his best completion to date.

Burr-Free Penetration

A new Burrless Bullet Cap, if desired, is inserted over the point of the improved Ogival Bullet at the time the M-3 Gun is loaded. It provides a completely burr-free hole on the inside surface of the perforated casing. Symmetrical, smooth holes make the use of ball sealers more effective in acidizing and sand fracturing—assuring more complete perforation shut-off.

Burr-free holes make casing scraping only a routine, precautionary measure and insure free passage of swabs, packers or other close fitting tools.

The jobs described above are certified to be true and accurate field reports of services rendered.

McCullough® TOOL COMPANY

Cable Address: MACTOOL

LOS ANGELES
HOUSTON
EDMONTON

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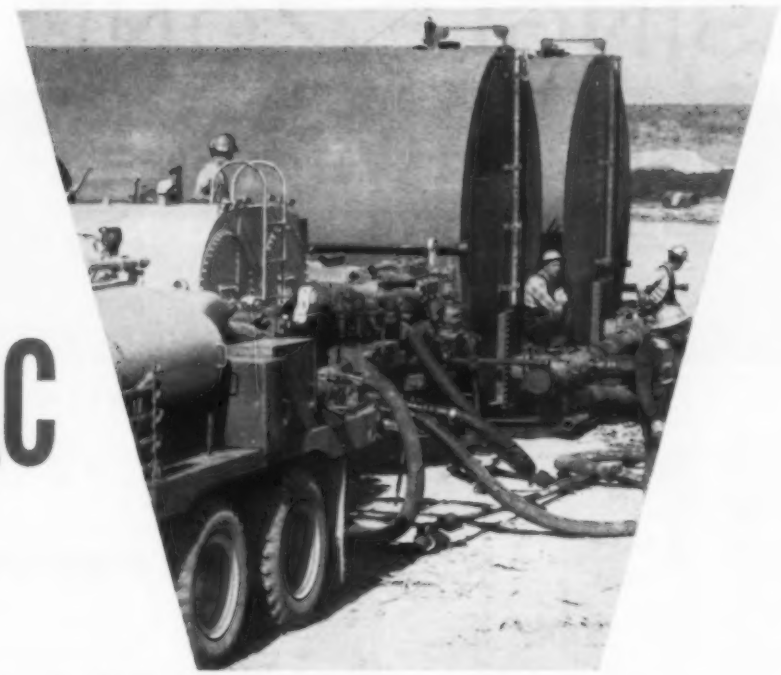
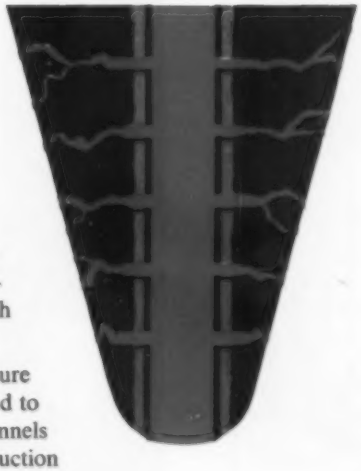
HALLIBURTON'S

ACIDFRAC



CREATES FLOW CHANNELS TWO WAYS AT ONCE



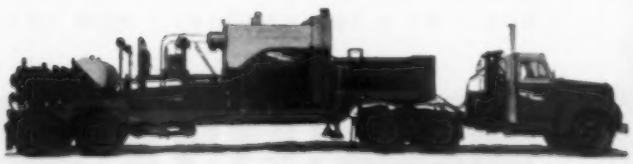
You get benefits of acidizing and fracturing in one treatment with Halliburton's Acidfrac Process.

This one-two production punch is especially effective in limestones, dolomites and limey sands.

Fluid used in the Acidfrac Process is an acid-in-oil emulsion. Because its chemical action is retarded by emulsification, acid effect is carried deeply into the formation. Emulsion thins with time and temperature, or with reaction.

Acidfrac is an effective sand carrier. Has temperature stability for deep wells. Strength of acid can be varied to suit well conditions. Because it enlarges flow channels two ways at once, Acidfrac often stimulates production more than conventional fracturing or acidizing treatments.

Get the complete story on Acidfrac from your Halliburton Fracturing Operator.



HALLIBURTON

OIL WELL CEMENTING COMPANY, DUNCAN, OKLAHOMA

PIONEERS IN FRACTURING SERVICES

251 SERVICE CENTERS—JUST MINUTES AWAY FROM ANY RIG

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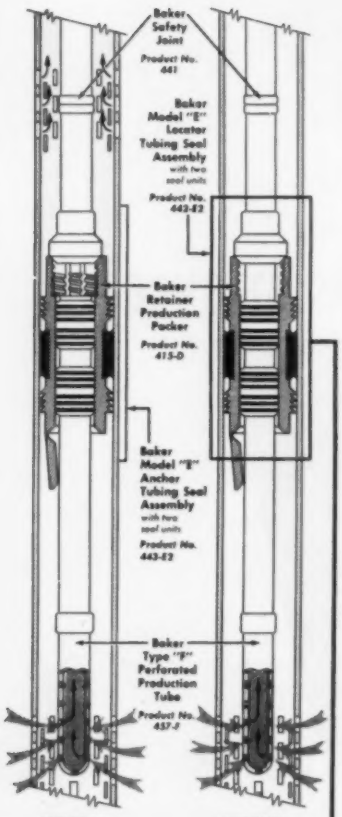
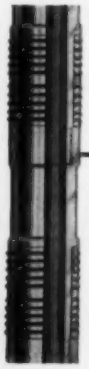
SINGLE ZONE

DUAL ZONE
PRODUCTION

WITH 1 BAKER

RETAINER
PRODUCTION PACKER


Baker Safety Joint
Product No. 441
Baker Model "E" Locator Tubing Seal Assembly with two seal units
Product No. 443-E2
Baker Retainer Production Packer
Product No. 415-D
Baker Model "G" Anchor Tubing Seal Assembly with two seal units
Product No. 443-E2
Baker Type "F" Perforated Production Tube
Product No. 457-J
TYPICAL DUAL ZONE HOOKUP
TYPICAL SINGLE ZONE HOOKUP



Right: Picture shows actual detail of seal units

Do you know that with only ONE Baker Retainer Production Packer you can equip your well for *either* SINGLE ZONE or DUAL ZONE production? And that you can accomplish *any* type of completion for *any* method of production to meet *fixed* or *changing* well conditions?

A single Baker Retainer Production Packer will also outperform many specialized tools when used as a TESTING PACKER • SQUEEZE PACKER • GAS LIFT PACKER • PERMANENT COMPLETION PACKER • WATER FLOOD PACKER • GAS INJECTION PACKER • CORROSION CONTROL PACKER • TUBING ANCHOR • ONE-WAY BRIDGE PLUG • PERMANENT BRIDGE PLUG.

Every production man should be familiar with the many operating advantages of this "Universal Type" Packer, which include . . .

WIRE LINE SETTING • SETTING UNDER HIGH PRESSURE • NO EXCESSIVE "SET-DOWN" WEIGHT OR TENSION • HOLDS PRESSURE FROM ABOVE OR BELOW • PACKS-OFF AND HOLDS UNDER HIGH BHT • RESISTS CORROSION • EASILY DRILLABLE.

Ask any Baker representative or office for complete details. There is no charge and no obligation for specific recommendations and completion planning advice available from Baker Technical Advisers. Why not be prepared for your next completion?

BAKER OIL TOOLS, INC.
HOUSTON • LOS ANGELES • NEW YORK

BAKER
RETAINER PRODUCTION PACKER

If your well is worth completing . . . it's worth completing well

New Barriers Broken In . . .

Drilling the World's Hottest Well

Where bottom-hole temperatures exceed 460 F near Laredo, Texas, Ginther, Warren and Ginther overcame the heat barrier in a 15,107-ft wildcat. Here's how it was done

R. E. (Bob) Keen,
Ginther, Warren and Ginther
Houston, Texas

IN OUR SEARCH for future oil and gas reserves, the most formidable limitation today in deeper drilling is the heat barrier. As matters now stand, the temperatures of underground formations that progressively go higher as the hole goes deeper, offer a more serious handicap to deep drilling than do the mechanical and engineering problems which have been the industry's gravest concern.

The oil industry's manufacturers and suppliers have concerned themselves with the improvement of steel, pipe, machinery, masts, etc. by beefing them up with metallurgical and mechanical improvements to support and operate longer strings of pipe to penetrate greater depths. Their progress has been excellent and there is little doubt that our fast-paced technology will soon produce equipment capable of drilling 35,000 to 40,000 ft.

But, before such great depths can be reached, the problem of drilling in high temperatures must be solved. Ordinarily, the temperature increases about 1 F with every 100 ft of hole drilled, and when a hole is of shallow or medium depth this factor is negligible. But in deep holes, temperatures encountered are of vital importance. In fact, in several extreme depth wells of exploratory nature in the past, the prime reason for discontinuing drilling, in some instances, has been the **heat barrier** encountered and its direct and indirect effect on mud, circulation, machinery, cementing, logging and other associated services.

For this reason, Ginther, Warren and Ginther's 15,107-ft wildcat drilled in an abnormal temperature zone near Laredo, Texas may well prove to be a highly significant step in the progress of deep drilling. A bottom-hole temperature of 460 F was accurately recorded at 14,552 ft, and without doubt, even higher temperatures were encountered as the well was drilled 555 ft deeper to its total depth of 15,107 ft.

Even though this well was not drilled to a world's record depth, it did encounter the highest bottom-hole temperature yet reported in the oil industry. To equal this temperature in a nor-

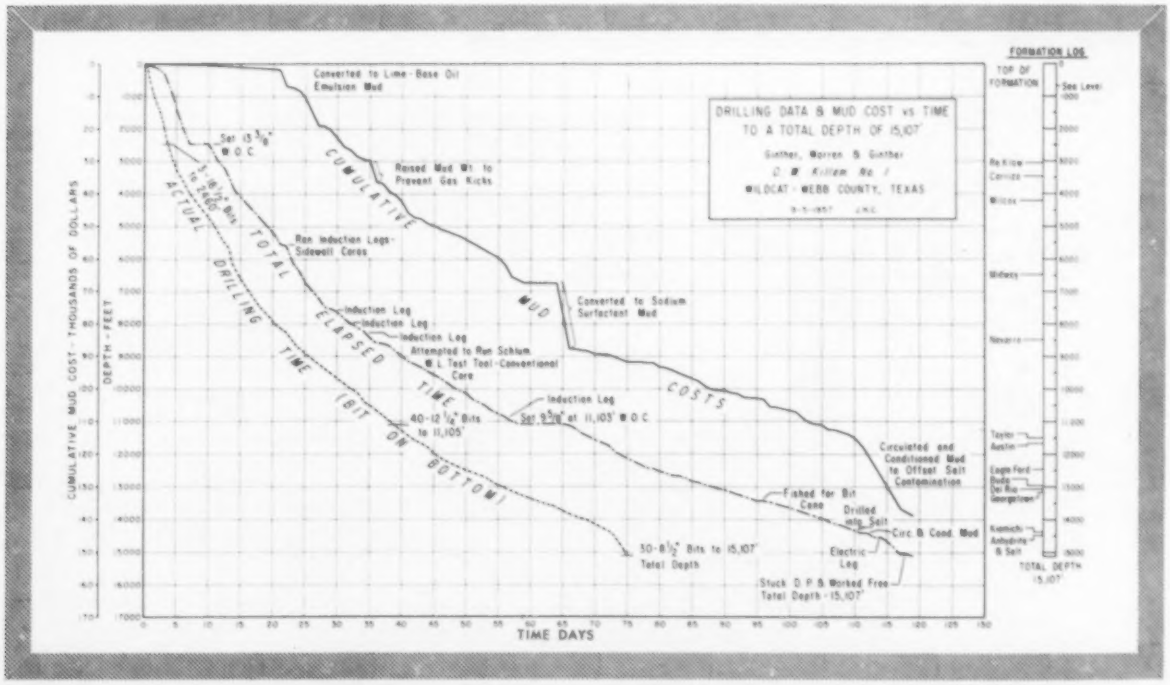

DRILLING DATA & MUD COST vs TIME TO A TOTAL DEPTH OF 15,107'
Ginther, Warren & Ginther
C. B. Killam No. 1
WILDCAT - WEBB COUNTY, TEXAS
FORMATION LOG
TOP OF FORMATION
Sea Level
Converted to Lime-Base Oil Emulsion Mud
Set 13 3/8" @ 0'
Raised Mud Wt. to Prevent Gas Kicks
CUMULATIVE
Ran Induction Logs-Sidewall Cores
Converted to Sodium Surfactant Mud
MUD
COSTS
Induction Log
Induction Log
Induction Log
Attempted to Run Schlum. @ L Test Tool-Conventional Core
Induction Log
Set 9 5/8" at 11,105' @ 0'
40-12 1/4" Bits to 11,105'
ACTUAL DRILLING TIME (BIT ON BOTTOM)
TOTAL ELAPSED TIME
Circulated and Conditioned Mud to Offset Salt Contamination
Fished for Bit Cone
Drilled into Salt
Circ. & Cond. Mud
Electric Log
50-8 1/2" Bits to 15,107' Total Depth
Stuck D.P. & Worked Free Total Depth - 15,107'
TOTAL DEPTH 15,107'
CUMULATIVE MUD COST - THOUSANDS OF DOLLARS
DEPTH - FEET
TIME DAYS

FIG. 1. **Graphic story of world's hottest well** tells little of the extreme problems involved. Drilling data and mud cost are plotted against the number of days. The geological column encountered in this well is also shown along with depth.

mal area, it would be necessary to drill 25,000 or deeper. But more important still is the fact that a number of the problems mentioned above were solved, and had the deep-seated salt dome not been encountered, *the well would have been drilled considerably deeper despite the still higher temperatures that would have been encountered.*

Heretofore, at temperatures considerably lower than those encountered on Ginther, Warren and Ginther's well, the problem of mud solidifying and cementing in the hole have absolutely prevented further drilling progress even at exhorbitant costs. This problem has been more than solved, because the temperature limitations of the mud that was used on this test are well above those encountered in this well. Much of the credit for overcoming this type of problem goes to the mud engineers who worked tirelessly to achieve mud fluidity at all times without encumbering drilling progress.

While some of the high-temperature problems mentioned above were solved, others were not. This is significant too, because the most important step in solving any problem is to recognize that it is a problem. Many of the service companies and manufacturers who followed the progress of the drilling and completion of this hole should have a fair insight into the requirements their equipment must meet in the deep, high-temperature drilling that will surely come in the future.

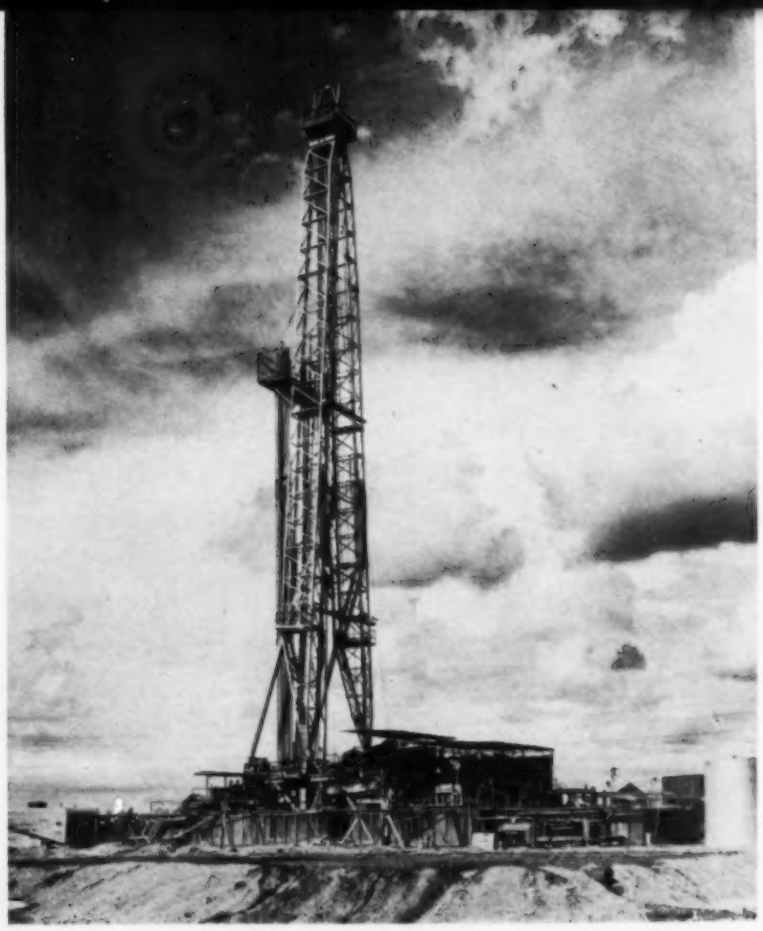


FIG. 2. **Largest rig seen in South Texas,** belonging to Dillard-Waltermire of Houston, Texas, was used to drill this super-hot wildcat.

Background of the Well

High temperature was not the only problem encountered on this well. Drilling was hard, formation pressures were high, and the location was somewhat remote so far as supplies were concerned. **Summed up, this test could be described as a West Texas wildcat, drilled in South Texas and encountering the abnormal temperatures, pressures and drilling conditions of the Gulf Coast.**

In addition, the well was a test of one of the largest unexplored geological structures in Texas — the Pescadito Salt Dome. This great structure has been well known ever since it was first mapped in the early 1930's by Dr. E. H. Sellards of the University of Texas. Through the years, seismograph crews have shot the dome repeatedly, and according to geophysical and geological work, this structure covers approximately 50 sq miles and has a closure of 6000 ft.

Several shallow tests have been drilled on this structure over a period of years but none showed commercial production. The one deep test came in 1950 when Sunray-Brewster-Bartle Drilling Company drilled to a total depth of 13,704 ft. Because of mechanical difficulties caused by high subsurface temperatures, the test was abandoned at this depth without reaching its prime objective — the Edwards limestone.

The latter formation thus far has proved elusive on this structure, yet the promises it holds are enough to excite the imagination of almost any oil man or geologist in the industry. The Edwards Trend has been one of the "home fields" of the independent oil operator almost since the beginning of oil production in Texas. A great number of the fields along the Balcones fault system that runs from the Corsicana-Mexia area southwesterly across Texas, are in the Edwards. This formation is one of the most prolific producing horizons in the state. A relatively high percent of the fields along this trend have produced more than 100 million bbl of oil, and some of the fields in this category are very small so far as area is concerned. For instance, the Luling field (discovered in 1922 and still producing) covers an area of little more than 2000 acres.

In the past year or so, the search for oil and gas along this trend has intensified as deeper production has been found in the Edwards in Southwest Texas. Lone Star Gas Company recently made an important gas-condensate discovery in Atascosa County and Amerada and Standard of Texas made discoveries in McMullen County. Seemingly, the Edwards thickens at these greater depths, and one of the companies above logged over 400 ft of pay zone in its discovery well.

A study of these recent discoveries as well as the enthusiastic cooperation of O. W. Killam who owns a major portion of the land on the Pescadito Structure, and from whom it was possible to secure the necessary leases, gave Ginther, Warren and Ginther the in-

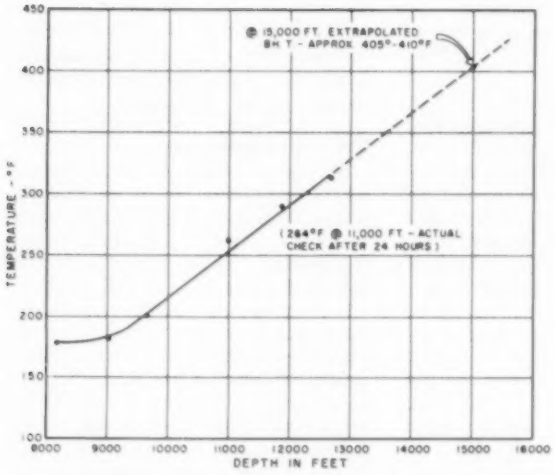


FIG. 3. **Temperature extrapolation** of previous deep well drilled by Brewster & Bartle in Webb County in 1950 indicated a bottom-hole temperature at 15,000 ft of 410 F. This later proved to be low.

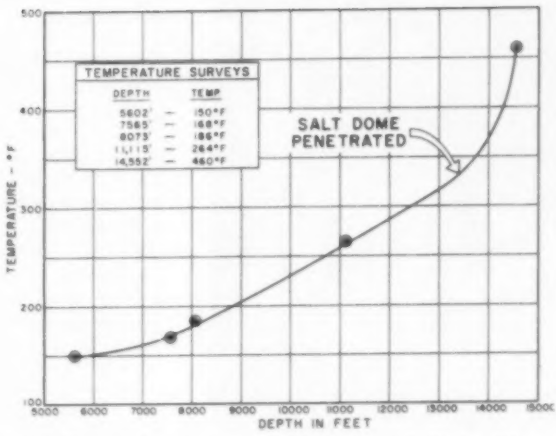


FIG. 4. **Temperature survey** of world's hottest well, Ginther, Warren and Ginther's O. W. Killam 1, in Webb County, Texas.

centive for an Edwards test. Killam was an early South Texas wildcatter, who discovered the Mirando pool, and being familiar with oil operations, he was able to acquire other leases to make the prospect even more attractive. It was his cooperation that made this test possible.

The drill site was located approximately 14 miles northeast of the City of Laredo in Webb County. With respect to other exploratory wells in the Edwards Trend in South Texas, this well was the furtherest out-post being located approximately 48 miles southwest of the nearest Edwards proved production. Geologically speaking, the well location was in the basin of the Rio Grande Embayment and above the apex of what proved to be Texas' deepest salt dome. Because of its distance from the Edwards Trend, various problems arose from a standpoint of correlating paleontology, electric logs, and stratigraphy. The surrounding wells — both in Texas and Mexico were too far away to be of great help.

Preliminary Planning

A thorough study and investigation was made of the drilling progress and problems encountered by Brewster-Bartle's Killam No. 1 drilled seven years ago. It was obvious from the first that high temperatures would be the number one problem; and from the various logs that had been released, temperatures were plotted to the well's total depth of 13,704 ft where the temperature had reached 335 F. As shown in Fig. 3, the temperature curve from this well was projected on to 15,500 ft. This extrapolation showed temperatures between 405 and 410 F would likely be encountered. (However, this proved to be in error, and considerably higher temperatures were encountered in the salt dome, probably a result of the high-thermal conductivity of the salt.)

Penetration rates of the previously drilled hole were studied and assumptions were made as to the high pressures that likely would be encountered.

Selecting a Mud Program

It was apparent from the outset that this well would require something special in the way of muds. Phosphate muds have a temperature limitation of approximately 190 F and lime base muds begin to be troublesome at about 275 F when the water loss control agents start breaking down. (Both starch and CMC begin breaking down at this temperature and must be continually replaced.) When the temperature of a lime base mud goes above 300 F, a complete breakdown of the mud is likely. This can occur in various degrees of severity — the worst comes when temperatures and pressures are sufficient to cause a chemical combination of the clays, lime and caustic to form a complex cement which will set up with the approximate strength of ordinary neat cement slurry. When this happens in the hole, it must be re-drilled.

Surfactant muds. In recent years, surfactant muds have been developed to solve some of the problems associated with deep drilling. These muds contain the usual benonite or gel and barites that have always been used in muds, plus certain additives that improve them for use in high-temperature, high-pressure drilling. Briefly, these additives are: (1) **A surfactant** that strongly adsorbs on the clays, flocculating them so the individual particles fit together, plate to plate, very much like a deck of playing cards. This limits hydration, and the thin surfactant coating prevents gellation and cementation. (2) **An electrolyte** (usually salt or calcium sulfate) which further retards the hydration of clays — those drilled or those already in the mud. (3) **A water loss control agent** that combines with the gel to seal the wall of the hole. (4) **Oil and an emulsifying agent** that holds oil in suspension, lowering fluid loss and lubricating at the same time the drilling operation.

Calcium surfactant mud would not suffice for the Pescadito test because it requires CMC as a water loss control agent and even in the environment of a surfactant it will not withstand temperatures above 350 F.

A new type low sodium mud provided the answer for the high temperatures that could be expected in the lower portion of the hole. Temperature range of this mud was extended considerably by a new experimental emulsifier, called HS-400-X, recently developed by Magcobar. This new additive not only emulsifies the oil but supplements the fluid loss control properties of Cypan (modified sodium polyacrylate). In laboratory tests, this mud had

FIG. 5. **The author** at left, discusses problems with Ginther, Warren and Ginther's chief engineer, James H. Courtney at right.

FIG. 6. **James N. McCaskill,** staff services engineer with Magcobar checks pH of new low sodium surfactant mud.

FIG. 7. **Mud in the pits.** Notice oil swirl at lower right.

successfully withstood temperatures as high as 450 F without breaking down or solidifying.

Final Mud Program

Based on studies of the stratigraphy, temperatures, drilling rates, bits, etc., a definite plan was developed for the most economical operation to a total depth of 15,500 ft, or 500 ft into the Edwards lime, whichever came first. In developing this program the mud program was correlated with the casing and drilling program. The following is a brief summary of this preliminary mud program:

1. Use a phosphate mud to the extent of its temperature limitation of about 190 F which would carry the test through the Wilcox sands to a depth of about 5600 ft.
2. Convert the phosphate mud to a low lime base, oil emulsion mud at 5600 ft and use it until the protective string would be set below the lower most Navarro sand at approximately 11,000 ft.
3. *After the protective* string of 9⅝-in. casing was set, replace the low lime base oil emulsion with the new high heat resistant sodium surfactant mud chosen for the deeper and hotter part of the hole.

Mud Logging

In view of the fact that some gas shows had been encountered by the other deep test on this structure, a mud logger was used from approximately 7000 ft to the end of the well. In conjunction with the conventional mud logging equipment, it was possible to obtain a mass spectrometer for the well, to be used experimentally for continuous fractional analysis of hydrocarbon components. This is a recent innovation in mud logging and the developers were anxious to obtain a correlation between the mass spectrometer and conventional mud logging equipment. The expected benefits to be derived from this type of logger was to differentiate between methane or "shale gas" and a valid show of gas or oil which would yield its normal compliment of its components.

Down-the-Hole Logs

In addition, successive correlative down-the-hold logs were planned during drilling progress as follows:

Induction logs would be run to a point of temperature limitation which was expected to be 325 F or approximately 13,500 ft deep. Further plans to place the induction tool in an oil bath to withstand high temperatures were discussed with the designers in hopes of logging to the deepest possible depths. After this log reached its limitation, it was planned to run either the conventional electric log or the gamma ray neutron log which could function in a higher temperature range than the electric logging instruments.

Drilling Contractor

Several bids were solicited from major drilling contractors in an effort to secure a deep well rig which could satisfactorily drill to a depth of 17,500 ft if desired. The successful bidder was Dillard-Waltermire of Houston, Texas, who was awarded a contract which provided that the well be drilled to an approximate depth of 11,000 ft (at which point protective casing would be set) on a footage basis of $10.75 per ft. All drilling below this depth would be on a graduated day work basis. The usual Gulf Coast mud clause was inserted in the contract, agreeing that when mud weights in excess of 13 lb per gal are used, the contract automatically reverts to day work rates.

Preparation of Drill Site

One major consideration in the drilling of this wildcat, was the lack of water in this locality. Surface water sands in this area are, for the most part, brackish enough to contaminate mud. Too, no surface sand in the vicinity had been known to provide a sufficient amount of water for drilling so it was necessary to secure a supply from adjacent lakes and cattle tanks. A contract for water was awarded the land owner.

Electric power was secured from the local power company in Laredo and made available at the rig by extension of high lines. All electrical equipment on the location consumed utility power.

Because of the great distance from supply points and for convenience in emergency situations that might arise, Ginther, Warren and Ginther built an air strip adjacent to the rig location.

The Author

R. E. (Bob) Keen is manager of drilling and production for Ginther, Warren and Ginther, Houston, Texas, independent operators. He has been in charge of all drilling and production operations since 1954 when he joined the firm. He was graduated from The University of Texas in 1937 with a degree in petroleum engineering and in 1939 received his degree in geology. During this time he worked for the Texas Railroad Commission. He started with British American Oil Company in East Texas, was advanced to district superintendent and moved to Houston where he became division engineer and assistant division superintendent. He took time out to serve 35 months in the U. S. Navy during World War II, and when discharged from the service, he was skipper of an LST. In 1947, he left British American to go with the Houston Independent Gas Company, in charge of the drilling and producing department. When this company was sold, he went with Scurlock Oil Company as manager of drilling and producing. In 1954 he joined Ginther, Warren and Ginther.

This was accomplished by bull-dozing off a level 4000-ft air strip and equipping it with temporary lighting system so it could be used at night.

Planned Casing Program

Here is the casing program originally outlined:

Size	*Approximate Setting Depth*
20-in. conductor	150 ft
13⅜-in. surface	2500 ft
9⅝-in. protective string	11,500 ft
7-in. liner	To top of Edwards, if needed

Note: If 7-in. was not needed and the well was completed as a producer, plans called for running 5½-in. casing from top to total depth or splicing the liner to the top of hole.

Cementing

The high temperatures down the hole promised to give trouble if ordinary cement was used. Certainly, in the lower portion of the hole common cement would heat up before it reached bottom. For this reason, samples of cement were sent to a specialty company where research work was performed to find retarder constituents that would allow a pumping time of at least four hours.

However, it might be added that in the course of completion, retarder constituents originally planned had to be modified because of the high saline content of the mud in the hole.

FIG. 8. **High temperature solidification test** being run by Bill Ward of Magcobar. Mud is heated to 435 - 450 F for 8 hours and its flowing properties checked.

Drilling Practices

The Ginther, Warren and Ginther, O. W. Killam No. 1 was spudded on February 20, 1957 and a total depth of 15,107 ft was reached 119 days later on June 18, 1957. The well penetrated the top of the salt dome at 14,394 ft, while drilling in the Kiamichi formation which is located immediately above the Edwards in geologic section. This precluded all chances of encountering the Edwards limestone which was the objective, but because there was a possibility that the salt was bedded rather than domal, drilling was continued 703 ft, the drill pipe stuck three times, but each time it was worked loose without fishing. Upon reaching total depth, the drill pipe stuck—probably as a result of plastic flow of the salt under temperatures in excess of 460 F and bottom-hole pressures in excess of 12,000 psi. It was necessary to dissolve the salt around the drill stem in the bottom by adding fresh water to the mud which at that time had reached 312,000 ppm of sodium chloride. The drill pipe was freed 6½ hours after adding water to the 17.5-lb mud, and it was recovered.

FIG. 9. **Material balance was maintained on mud system.** Shown here is the water meter which recorded makeup.

Penetration Rates with New Mud

The penetration rates while using phosphate and lime base mud were comparable to those of a conventional well. *The penetration rate while using sodium surfactant mud from 11,000 ft to total depth was believed to be in excess of normal drilling rates with any type of lime base mud because of the new mud's ability to*: (1) Control viscosity between 60 and 80 sec, (2) minimize high solids content, (3) carry 7 to 8 percent oil in mud satisfactorily, and (4) achieve a theoretical reduction of viscosity range in down-the-hole temperatures which certainly were in excess of 190 F. The penetration rates are shown on Fig. 1.

Viscosity down the hole. It is interesting to note that viscosities of 70 to 80 sec funnel measured at the top of the hole were actually much lower viscosities (in the range of 40 to 50 sec funnel) at bottomhole conditions because laboratory tests indicate that this mud thins at higher temperatures.

Although the mud flowing from the standpipe into the hole was usually about 150 F and the mud coming out the flow line was about 170 F, there is little doubt that the mud temperature in the bottom of the hole approached bottom-hole formation temperature. The circulation time was about two hours, and as the mud made its almost three mile trip down the drill pipe it constantly picked up heat from the *hotter* mud on the outside of the pipe. By the same token, as the mud circulated up the annulus, it was progressively cooled by the incoming mud in the drill pipe. Thus in effect, the drill pipe and annulus formed a 15,000-ft long counter-flow heat exchanger that would insure maximum high temperature at the bottom of the hole and minimum differential at the top.

One significant feature of this new mud was that at no time was it necessary to break circulation when making a trip in the hole. In every instance, normal circulation was established immediately on reaching bottom — even though the mud had been standing at high temperatures for more than eight hours!

During drilling progress, a continuous study was made of mud temperatures by the installation of a recording thermometer on the flow line. The chart reflected all fluctuations of temperature as caused by a reduction of pump rate or any mechanical failure that might have occurred during drilling. The average flow line temperature below 14,000 ft to total depth was approximately 165 F. A maximum of 179 F was recorded at the flow line. (The effect of this high flow line temperature on integral parts of the rig was significant.) This temperature record was very helpful in solving many immediate mud problems that arose and in determining the correct chemical equilibrium that had to be maintained and controlled in this type of mud. Typical data recorded on the circulating system were:

Depth drilled — 14,271 to 14,354 ft — Average 3.31 ft/hr.
Weight — 16.8 lb/gal.
Flow line temperature — 171 F.
Annular velocity — 166 ft/min.
Bit size — 8½ in.
Average jet velocity — 163 ft/sec.
Size jets — three ½-in. jets.

Size drill pipe — 4½ in. modified.
Total circulating time — 122 min.
Total mud system — 1424 bbl.
On an average measure of temperature between flow line and suction pits — 15-20 F.

Bit Record

Various types of bits were used to drill hard formations encountered in this well, and all were jet bits. Considerable care was given the selection of the jets and the result was an optimum rate of penetration. The average bit life between 13,000 and 15,000 ft was 32 hours.

The bit record of this hole is as follows:

No. Used	*Size Bits*	*Depth Attained*
3	18½ in.	2460 ft
40	12¼ in.	11,105 ft
30	8½ in.	15,107 ft

Drilling Rig

Dillard and Waltermire's rig on this hole is one of the largest and most powerful ever seen in this area. The 143-ft mast has a load capacity of 850,000 lb and the substructure can support 1,000,000 lb. The drawworks, which has automatic controls, is powered with three 800-hp diesel engines. Using 5¼-in. liners, the two mud pumps operate at 2175 psi to provide ample circulation for jet bits.

Trip time averaged 8 to 9 hours between 13,000 and 15,000 ft. A minimum of tight hole trouble was encountered in all trips, and at no time was the pipe stuck during a trip. As mentioned above, one of the greatest benefits derived from the type of mud used was the rig time saved in avoiding the necessity of breaking circulation between top and bottom of hole as is customarily done in deep hole drilling. In this well, it was never necessary to break circulation, prior to reaching bottom in making a trip, and all initial circulation pressures following trips were normal.

As reflected on Fig. 1 which shows drilling rates and accumulative mud costs plotted against the total time consumed in drilling the well, approximately two-thirds of the time was spent on bottom drilling. Because of the hard formations, no controlled drilling was necessary.

As many as 19 drill collars were used in the last 1000 ft of hole and the contractor achieved a hole that did not exceed 3° vertical deviation. In the bottom 2000 ft of hole, excepting the salt section, a maximum of 32,000 lb was run on the bit and weight was controlled by the addition of drill collars at intervals.

Other Effects of High Temperatures

Drilling with hot mud changed the pattern of operations at the surface as well as down the hole. Some of these changes were:

1. High-pressure, high-temperature thread lubricant had to be used on tool joints to prevent leakage.
2. High temperatures affected the maintenance and service of pump parts; liners, valves, etc.
3. High temperature of the mud inconvenienced the crew, and pulling a wet string was a source of possible minor burns. However, the chemical neutrality of the mud — being neither acidic nor caustic—more than made up for this inconvenience, having no detrimental effect on the men or the rig paint, etc.
4. Because the high temperatures at the bottom of the hole scorched the film in the straight hole surveying instruments, straight hole shots were discontinued at about 13,000 ft.

Summary of the Costs of the Well

Surprisingly enough, the cost of drilling this hole was not out of line with those of other exploratory wells drilled in hard rock country. Excellent penetration rates, plus the fact that the bit was on bottom and rotating about ⅔rds of the total elapsed time kept the costs within reasonable limits. And, trip times were somewhat shortened by the fact that the new mud used on this hole did not require breaking circulation during the trip to bottom. A rough breakdown of the various costs is shown at right.

		Cost	*Percentage Cost of Total*
Footage	$ 98,800.00		
Day work	101,300.00		
Total contractor's cost		$200,100.00	37.47
Mud and chemicals		137,700.00	25.78
Casing (includes surface equipment, float equipment, welding and cementing)		108,200.00	20.25
Bits		25,400.00	4.75
Equipment rentals (de-gasser, centrifuge, etc.)		17,600.00	3.29
Water, diesel for mud		14,100.00	2.64
Electrical logs, surveys, etc.		11,800.00	2.21
Geological and engineering supervision		8,500.00	1.59
Hauling		7,100.00	1.33
Roads, location, pits, etc.		1,700.00	0.32
Miscellaneous supplies and services		2,000.00	0.37
		$534,200.00	100.00

Logging in High Temperatures

Difficulties were experienced with conventional logging as a result of the high temperatures. A directional survey run at 11,000 ft showed that the film was barely discernible after being subjected to 264 F. *Induction logs* were run to 13,106 ft but beyond this point it was necessary to resort to conventional *electric logs* to reach 14,552 ft. Below this point it was believed that no satisfactory electric log could be run because this portion of the hole was above 450 F. However, a *gamma ray neutron log* was run successfully from total depth to the top of the hole and it correlated with the electric log. It is interesting to note that at the time the last electric log was run, the hole had penetrated 158 ft into the salt and the sodium chloride content had increased from 10,000 to 53,000 ppm, yet an interpretative low was successfully run because the mud resistivity at bottom-hole temperature of 450 F was 0.05 ohms.

No trouble was encountered at any time during logging at these bottom-hole temperatures with gamma ray-neutron logs.

Sidewell samples were successfully taken as deep as 8030 ft but none were attempted below this depth since temperatures were in excess of the tool's maximum operating conditions which approximates 325 F. For this reason, it was originally planned to diamond core the Edwards lime had it been encountered.

FIG. 10. **Inside the mud logging trailer** Rene Herbert of United Core, Inc., watches mass spectrometer chart which shows fractional breakdown of hydrocarbons in mud.

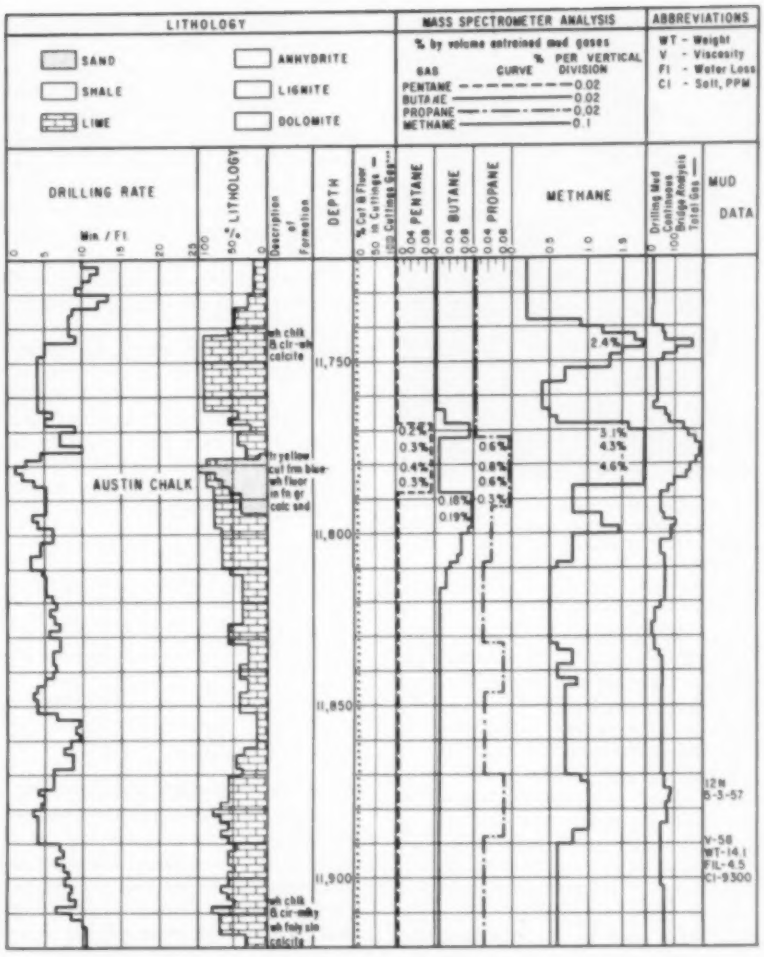


FIG. 11. **Mud log showing breakdown of hydrocarbons by mass spectrometer.** Continuous sample is pulled off mud and this record is made along with conventional mud log.

Mass Spectrometer Logging

The mud logger was placed on the well at 7250 ft just above the Navarro formation and it was used all the way to total depth. In conjunction with it, and recording on the same chart, was the experimental mass spectrometer mentioned earlier. This instrument pulled a continuous gas sample from the mud (when gas was in it) and broke it into fractional components. When the only component shown on the log was methane, it was apparent that "shale gas" had been encountered. The presence of heavier hydrocarbons could be taken as an indication that a valid show had been penetrated. This proved true, from a qualitative standpoint, in both the Georgetown lime and the Austin chalk formations which were later tested. However, these tests proved the shows to be high-pressure gas with insufficient volume for commercial production.

Down-the-Hole Temperatures

Because temperature was to have a major bearing on the success or failure of the well, serious consideration was given the problem of obtaining accurate temperature readings at various depths as drilling progressed. Each time a logging instrument was run in the hole, a thermometer was attached and a reading attempted. On several runs, no reading was obtained because the mercury was shaken down as the instrument was coming out of the hole. Inverted thermometers were run on two occasions on logging tools but no better results were obtained.

A successful run was made, however, when three thermometers were run on a wire line during one of the logging operations. Two of the thermometers were sealed in oil bath containers and the third was sealed in air.

Here are the results of this run which was made at 14,552 ft:

1. Sealed in air	395 F*
2. Immersed in oil	440 F
3. Immersed in oil	460 F

*Note: Thermometer inadvertently run in air instead of oil bath, and was considered incorrect.

One of the obvious needs for future high-temperature holes is a method of accurately taking down-the-hole temperatures during logging operations.

Details of the Preparation and Maintenance of the New Surfactant Mud

Despite many difficulties encountered because of high temperatures, the new low sodium surfactant mud was highly successful. It required little maintenance, and the upper temperature limit was not reached on this hole which certainly exceeded 460 F before total depth was reached. Gas entrainment was negligible and fluidity was maintained at all times.

Low sodium surfactant muds were recently developed by Magnolia Petroleum Company to withstand the elevated temperatures of holes such as this. However, for this particular hole Magcobar's recently developed heat stable emulsifier was used for the dual purpose of emulsifying the diesel oil in the mud and supplementing the fluid loss control characteristics of the modified polyacrylate.

FIG. 12. **Checking flow line temperature recorder** which is a tattle tale of drilling operations. For instance, when pump pressure is lowered the temperature falls.

The success of this mud is best illustrated by the fact that in 24 days of drilling, the fluid loss remained stable varying between 3 and 4 cc without the addition of modified polyacrylate or any other fluid loss control agent!

Changing the mud over. As mentioned above, phosphate mud was used to a depth of 5600 ft and broken over to a low lime base mud which carried the hole to 11,103 ft where the protective string of casing was set. At this point, while waiting on the cement, the lime base mud in the pits was displaced to the reserve system; then the piping and mud pits were thoroughly cleaned and washed down with fresh water. The reason this was necessary is that a low sodium mud system should be essentially calcium free.

The mud was then mixed in the pits, starting with a water-bentonite slurry which was thoroughly gunned for about three hours. Then DMS and salt were added and this was followed by Cypan. Next, diesel oil and HS 400 X emulsifier were worked into the mud and finally barites were added to provide the proper weight.

Three batches of surfactant mud were mixed in the pits and pumped into the hole behind a water blanket (through drill pipe inside the casing) which was used to separate the two systems. The lime mud, water blanket and approximately five barrels of surfactant mud were displaced into the reserve system. After the mud had been circulating for several hours it had the following properties:

Weight	14	lb/gal
Funnel Viscosity	48	sec
Gel strength	3	lb/100 ft²
10 Minute gel strength	8	lb/100 ft²
Fluid loss	6.2	cc
ph	8.2	
Salt content	16,000	ppm
Calcium	40	ppm
Oil content	8%	
Solid content	22%	
Floor temperature	134	F

Mud Pre-Treated for Cement

After the surfactant mud was completely made up and circulated, the cement plug was drilled. The mud had been pre-treated for cement, so no adverse effects were experienced with the mud. Drilling was resumed.

Field Checks on the Mud

Because this particular mud was undergoing its first test in the field, the mud company moved a portable laboratory to the location and set up a laboratory routine to check all physical and chemical characteristics of the mud at about four-hour intervals. The primary reason for this was to gain as much information as possible on the relatively new mud system.

These mud checks indicated that this system was very stable, changing little from day to day.

In addition to the routine checks, continuous pilot testing was carried on at elevated temperatures and a material balance was continually run on the well. A record was kept of all the water, barites and other materials that were added to the system. The pit volume was recorded so the amount of fluid lost down the hole or to evaporation could be ascertained.

Effect of Drilling in Salt

As previously mentioned, the salt dome was penetrated unexpectedly. The effect on the mud system was not great — even though the salt content of the mud increased from 11,000 ppm up to saturation, or perhaps super-saturation. The primary effects were a slight increase in viscosity and fluid loss. The viscosity was increased by about 20 sec per qt as measured by a Marsh funnel at surface temperature, and the water loss increased from about 4 cc up to 15-16 cc for a short period of time. The latter was lowered with additives.

A low sodium surfactant system behaves very much like a fresh water system that has been buffered to minimize the effect of contamination. Actually, a surfactant system is not nearly so susceptible to contamination as a fresh water system.

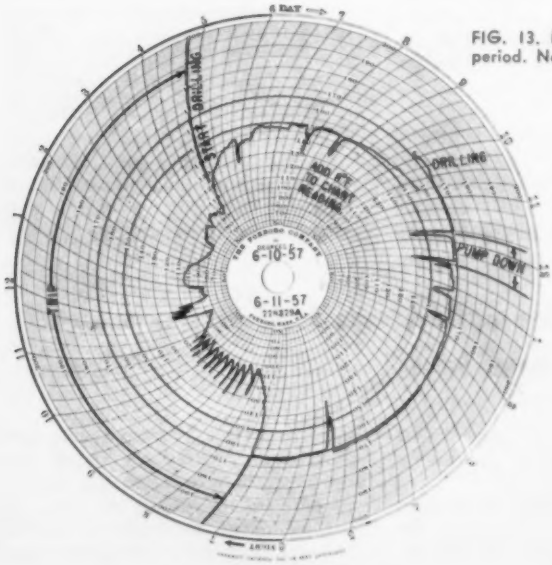


FIG. 13. **Recording of flow line temperatures** over a 24-hour period. Note how temperatures fall during round trip.

FIG. 14. **Men behind the well,** left to right: Howard C. Warren, Wilbur L. Ginther and George C. Clement of Ginther, Warren and Ginther; Bill Callahan, consulting geologist and author Bob Keen.

Advantages and Disadvantages of the New Mud

Summed up here are the advantages and disadvantages of this new mud:

1. **It will withstand high temperatures above 460 F without gellation or cementation. It is not necessary to break circulation at intermediate points when running in the hole.**
2. **The gel strength and viscosity of this type system are fragile and the gas or air trapped in the mud during drilling easily break out of it.**
3. **The daily maintenance cost is low because the materials in the mud do not break down, and therefore do not develop viscosities or gel strengths which would require watering back. Any addition of barites is to increase the mud weight.**
4. **This mud will not remove paint from the rig or burn the skin or eyes of the crew men because its pH is maintained at about 8.3 to 9.2.**
5. **There is little contamination from mud making shales.**

The primary disadvantage of the mud is its initial cost. However, on deep holes the cost is offset by the low daily maintenance.

Another disadvantage is the fact that the pH must be carefully controlled and if green cement is to be drilled, the mud must be pre-treated.

Completion of the Well

A cement plug was set in the open hole from 14,250 to 14,550 ft to prevent contamination of the mud and to seal off the salt section from possible producing zones up the hole. Because of the high temperature and the high salt content of the zone, special retardants had to be used in the cement.

Because of the tight nature of the Georgetown formation, an open-hole completion of this zone was attempted. A 7-in. liner was set from 10,835 to 12,898 ft, leaving an open-hole section of approximately 1300 ft. Purpose of the liner was to shut off a sloughing shale zone immediately below the 9⅝-in. casing at approximately 11,200 ft and to make possible the testing of the Austin chalk zone at 11,750 ft.

The subsequent test of this hole was difficult, to say the least, and the lack of equipment and tools designed to withstand high temperatures encountered in some instances amplified the problem. A test of the open well section started when a tool was run to the bottom of the liner and left open for 17½ hours. The result of this test was a slight blow at the surface indicating a tight formation.

After pumping in 8000 gal of acid, the well was put on test again and showed 2400 psi surface pressure when the drill pipe collapsed. On a subsequent test, the choke in the tool plugged, and the formation was re-acidized with 4000 gal of acid. This time, the drill pipe plugged and the wire line bailer run inside the pipe was stuck. The drill pipe was taken out of the hole and another test was started.

While circulating to condition the mud, a pin on the 2⅞-in. drill pipe parted; however, the fish came out easily with an overshot. The mud in the open-hole section was displaced with diesel oil and the well again put on test, and again the drill pipe plugged. The pipe was filled with water and pressured up in an attempt to unseat the packer, but the drill pipe parted.

Attempts to pull the fish with an overshot were unsuccessful, and the tool would not disengage from the fish. The high temperature in the hole rendered the string shots ineffective, but eventually the fish was recovered.

A retainer packer was set at 12,830 ft and the weld perforated from 11,739 to 11,801 ft to test the zone behind the liner. Despite numerous fishing jobs during this phase of the test, it proved non-commercial because the formation was too tight. However, when a bridge plug was set at 4500 ft and the zone was block-squeezed for production, the drillstem test indicated low-volume gas production. The well was temporarily abandoned.

One of the obvious conclusions to be gained from this completion is that equipment must be devised to withstand elevated temperatures.

CONCLUSIONS

1. The new low-sodium surfactant mud is adequate for the high-temperature, deep drilling that lies ahead. For this service, it is economical and easily maintained.
2. Logging equipment should be improved to withstand higher temperatures.
3. Accurate methods of taking bottom-hole temperatures should be devised. They should be run in connection with the logging equipment.
4. Mud logging is a valuable tool in holes of this type when used in connection with other logs.
5. The mass spectrometer method of logging mud returns can differentiate between "shale gas" and heavier hydrocarbons.
6. String shot equipment should be improved to withstand higher temperatures.
7. Certain of the perforating guns should also be improved to withstand higher temperatures.
8. Straight-hole deviation instruments should be improved to withstand high temperatures.
9. Cement additives should be developed to adequately provide services for wells of this type.
10. Packers should be devised with seals to withstand these temperatures.

Acknowledgment

The author wishes to express particular appreciation to Howard C. Warren, Wilbur L. Ginther, Noble C. Ginther and their associates in connection with this project for their permission to use the information contained herein; and to O. W. Killam, oil operator and land owner; to Fred Waltermire, Contractor; to Tom Neal, Drilling Superintendent of Dillard-Waltermire; to Bill Ward, Jack Carrol and Bill Dowden, Magcobar engineers; to Bill Callahan, Consulting Geologist, Laredo, Texas; to Dr. George C. Clement, Chief Geologist, Ginther, Warren, and Ginther and to all the other employees of Dillard-Waltermire, Magcobar and Ginther, Warren and Ginther for their help and cooperation in connection with the drilling of the Ginther, Warren and Ginther O. W. Killam, No. 1, with an especially grateful acknowledgment to James N. McCaskill, Magcobar Staff Engineer and James H. Courtney, Petroleum Engineer for Ginther, Warren and Ginther for their assistance in the writing of this article. ★ ★ ★

I believe in . . .

INCENTIVE PROGRAMS—

. . . says W. R. Harrington,

Vice President and Safety Director,
Gardner Brothers Drilling Company
Dallas, Texas

I BELIEVE IN SAFETY WORK.

I believe in the effectiveness of **any** effort by **anyone** toward the reduction of injuries.

I believe in using any tool which will effectively promote safety.

I believe in the use of incentive programs in safety work and I know they can be effective.

I believe incentives are perhaps the best single tool when properly applied. I do not mean to imply that incentives alone will do a complete safety job. Certainly an incentive program will not remove physical hazards from the working area of the employees nor will it do a thorough job of training your employees in correct and safe operating procedures.

There is no ONE effort that will do away with accidents or injuries. There is no one cure-all. If there were, I would certainly want it for my safety program and I am certain that you, too, would be delighted to find the magic formula. In recent years penicillin and the other antibiotics have become known as miracle drugs, but certainly no one believes that they will ever do away with the practicing MD. Antibiotics will not set broken bones nor soothe the suffering nor cure the many ills which are not affected by these magic drugs. As in medicine, an incentive program will not replace the safety engineer, the program of selection and training nor the program of inspection which is responsible for removing physical hazards. When properly applied, incentives can and will do a big job in any safety program.

Incentive Programs Work

Incentive programs are working for many drilling contractors. In this industry facts are hard to obtain that would show what all contractors are doing in any particular field. I have been unable to find any source that would give me the information I would like to pass on to you. From several reasonably authoritative sources, however, I have compiled a few facts which I consider to be very conservative. I have been able to determine that there are at least 150 contractors representing about 800 rigs now using the gloves incentive plan. Of these less than 4 percent discontinued the plan within the first 90 days and none of them have stopped the gloves incentive program after it had been used more than the three months.

I know of 10 contractors using merchandise incentive plans. There are six giving safety shoes and three giving coveralls as safety incentives. These contractors are all convinced that their incentives programs are paying off and helping them do a better job in safety. One contractor has had a safety program run by a competent safety engineer for many years. His program included all the usual good basic safety plans and in addition his company gave all employees vacations. As an experiment, work gloves were given to the employees and became strictly a safety award. This particular contractor claims the gloves program cut his injuries exactly in half as compared to the normal injury rate under a safety program without incentives.

One contractor told me that his return dividend the first year of his incentive program was 4½ times the cost of his gloves awards. This contractor told me that he knew the cost of his incentive program would gradually approach the amount of savings he could recover yet he considered the 4 to 1 ratio of hidden costs as his biggest compensation in inaugurating the incentive plan.

Program Not Costly

Just to point out that a great many awards are actually incentives but are not in any way costly, I would like to give you the 1956 AAODC figures on the drilling industry safety awards.

Fifty drilling contractors took advantage of the safety awards program and issued 638 certificates, 56 rig award plaques and 1551 wallet cards. Certainly these awards are of no great monetary value but I know from experience that they do act as incentives and the crewmen in the drilling industry are very proud of them.

As I said before I can't prove many of the above figures. I personally am sure they are conservative but there are some facts that I can give you which can be proved and I will vouch for their validity.

The incentive program in effect in Gardner Brothers Drilling Company is working. We have reduced our loss ratio from 143 percent to a figure of 18 percent for the last six months.

This is indeed an impressive figure, however, I am sure most of you know that loss ratio figures too often give a false picture of the process of a safety program. Certainly a company with an extremely bad record can make even mediocre progress look as though they are setting the world on fire by the use of these comparisons. After all, a loss ratio is just that — a comparison. It is figured on the basis of comparing your current losses to the money you give to your insurance carrier as premiums based on your previous experience.

I believe a more accurate comparison of periods of time within a company or a comparison of one company's record with another may be better expressed in terms of hours of exposure. For instance, I have now started keeping my comparison figures in terms of injuries per units of man-hours and a type of severity comparison figure in terms of loss in dollars per unit of man-hours.

Continued on page B-32

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—THEIR FALLACIES

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TWO YEARS AGO I BEGAN TO SEE THE LIGHT ON THE FALLACIES OF INCENTIVE PROGRAMS.

We had two programs — one in our transportation department and one in the drilling department. I was the father, so to speak, of these programs and frankly I was quite proud of them. In my visits on rigs and with the truck drivers, the men quite often mentioned these programs — usually by asking when they would receive their new award. To me, this indicated that these prizes and awards were foremost in their mind and as such would be a compelling force in making them work more safely.

The dawning of this light came one day while I was talking to a truck driver and his statement was in effect, "Sure, I like these prizes and my wife is quite proud of the ones we have at home and I appreciate them. But, if you think that I am thinking about them when I am driving my truck along the highway or through the city of New Orleans and this thinking causes me to be more careful, you are nuts. My job is to drive this truck and get these loads to their destination without tearing the truck up, losing the load, injuring myself, or someone else. That's what I have in my mind when I am driving — not whether or not my wife is going to be able to order the prize she has picked out in the catalog."

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Since that time I have asked other employees throughout the company if they could truthfully say that the prospect of receiving some type of gift or award actually entered their minds while they went about their regular work.

As yet, I have to find one who would so state even though all of them were quick to tell me that they appreciated the gift and that they thought the program was wonderful and that the only way it could be improved was to give bigger and better gifts.

Perhaps I should point out here that the cost and magnitude of our incentive programs compared to some now operating is somewhat like comparing the old radio show "The $64 Question" to the now famous TV show "The $64,000 Question." But regardless of the monetary values involved, an incentive program is an incentive program.

A Hypothetical Case

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Continued on page B-33

"The Point is: They Work"...

Continued from page B-30

Let me give you an example of what has been done within our organization. Before the beginning of our safety program as such, our frequency was .378 injuries per thousand man-hours. During the year the safety program was inaugurated this figure rose to .498 injuries per thousand man-hours. Our most recent figures show that our rate is now in the neighborhood of .17 injuries per thousand man-hours. The severity has likewise dropped from well over $100 loss per thousand man-hours to the present rate of something under $40 loss per thousand man-hours. This type of progress is not at all unusual among contractors who begin a safety department because of an extremely bad safety record. I can honestly say we have done a good job safety-wise during the past three years.

A great deal of the credit for this improvement is due to our incentives programs. Not all the credit, mind you, but a great deal of it is attributable to what others may call a "giveaway" program. We never like to think of our program as a giveaway in any sense of the word. We tell our employees, and I preach it everywhere I go, that it is really a savings sharing plan.

We do not give our employees a reward for working safely, rather we consider the problem from the standpoint of returning to the man a portion of the money saved through extra efforts.

What Are the Incentives?

By definition, an incentive is "that which influences or encourages to action: Motive, spur, stimulus; as, the desire for promotion is often a powerful incentive to action." According to this a pay check is an incentive. It creates a motive. The possibility of being fired may also be an incentive for it too is a spur to action — sometimes. Incentives come in as many variables as women's figures. They may be large or small, valuable or insignificant, real or intangible. Suppose for a minute we run over what some of the incentives being used today consist of and how they might be classified. There are permanent programs, intermittent programs and the one-time, one-shot promotions. Among the permanent programs which give awards on a regular everyday basis are the following incentives:

Gloves	Barbecues
Shoes	Pins
Hats	Cards
Coveralls	Other records
Insurance	awards
Vacations	Merchandise
	(point system)

Intermittent programs are not used a great deal but under this classification are the seasonal promotional deals. These I use quite often myself and try to make each a little more interesting than the last. These may consist of some sort of contest for a particular holiday, a promotional program for vacation safety, or any other seasonal activity.

One-Shot Deals

Among the one-time one-shot promotions are classed such one-time efforts as may be produced for a specific purpose, such as:

1. Educating or impressing new employees when starting up several rigs.
2. Producing needed stimulant to lagging interest.
3. To promote a suggestion appeal.

These are designed and used to accomplished a specific goal. There are many types of incentives that may fall in any of these classifications. They all work; they are all effective; but they must be tailor-made for your organization.

As you can see, incentives may be classed as almost anything which creates a desire but let us limit our discussion today to tangible awards. Personal praise is very important in handling regular personnel. Personal achievement should be personally recognized, but for the moment let's stick to the real material incentives.

Any competent safety engineer or any member of management directly concerned with a safety program in his organization should realize that there are many tools available to him just as a carpenter carries a big box of tools when going to his work.

Everyone attempting to get results in this field of safety has certain tools to use. Among these safety tools are the rules and regulations of his company, safety meetings, inspections, publications, hiring procedures and training programs. Another tool just as important and perhaps a little more dramatic in its effect, is an incentive program. Now we may not all like incentives. It may be against our principles. You may be one of those people who insist that an award program amounts to bribery. In some instances an award program may be distasteful to you. Certainly an advertising man must have a good sense of taste to be in that type of work and I am sure that some of the soap operas and singing commercials are to some degree distasteful to him. Yet these things do have a place — and they are effective. If an award program is in any way distasteful, perhaps you should consider the possibility that its good effects may offset the bad.

I believe in using any tool which will effectively promote safety. If it is not illegal or immoral and will get the job done, let's use it.

"If the Glove Fits, Wear It"

Surely, you will all agree that each and every safety program must be made to fit the particular company in which it will be used. The same is true of an incentives program. It must be personalized and tailored for a specific application. In our case machinery is set up for handling an awards program to fit our company, our methods of handling payrolls and records, and to more or less suit the personality of our company (see Gardner Brothers personnel program printed here). Any company, whether a large corporation or a small individual or partnership group, does have a personality and its programs certainly should fit in with their way of doing business.

We looked for several things to fill the needs of our incentives programs. As a result several plans are now in use

Continued on page B-34

The Author

William Robert Harrington is vice president and safety director of Gardner Brothers Drilling Company. He holds bachelor of science degrees in aeronautical engineering and mechanical engineering from Tri-State Engineering College of Indiana and his first oilfield work was in Mississippi as a roughneck for Gardner Brothers. The company is Harrington's first, only and present employer in the oil industry.

He began Gardner Brothers' safety program in 1953. He is a member of the National Safety Council, the AAODC Safety Committee, and the Drilling Industry Society of Safety Engineers.

Harrington is now assuming leadership of a new Canadian subsidiary of Gardner Brothers and will be located in Calgary, Alberta.

Their Fallacies

The Financial Burden is too Great

Continued from page B-31

that can be given away. By this time, Crown Block is really worked up. He is going to show them. If safety records are what they want, he'll have the best safety record in the drilling business. If a little bit would do a little good, a whole lot would do a lot of good.

The next step is to call a meeting with his superintendents and toolpushers. His message is something like this: "Men, the Square Hole Drilling Company has had its last lost-time accident. We are instituting a safety program and this is how it works. For every 30 days a man works without a lost-time accident, he gets an award. When he works 60 consecutive days without a lost time accident, he gets another award. If an entire crew works 90 days without a lost-time accident, all of the crew, including the driller, get another award and the driller gets still another award. If the entire rig works 90 days without a lost-time injury, in addition to the above, the toolpusher will get a $150 cash bonus and we will have a steak dinner for all the employees on that rig and their families. If the entire rig works 6 months without a lost time injury, the toolpusher will get a $250 savings bond and each driller a $150 savings bond."

For the next 15 minutes, Crown Block elaborates on the voluminous list of prizes and awards that the employees will get if they do not have a lost-time accident. His list is too lengthy and time consuming to give you here; but it includes vacations, TV sets, and their equivalents.

But his closing remarks are the most important part and they are, "Men, I am serious when I say that we are **not** going to have any more lost-time accidents. With the safety program that we have in effect, if you toolpushers can't keep these knuckleheads from having these stupid and uncalled-for accidents that we have been having. I'll get some toolpushers who can.

"Now I know that you can't lead these worms around by the hand 24 hours a day so I am going to give you a little leeway. Our definition of a lost-time accident will be any injury that incapacitates a man to the extent that he cannot return to the rig the following day. I don't care if he breaks his arm, you get a cast on it and get him back out to that rig and let him do something even if you have to hire another hand to work in his place on the floor. If you get too many cripples out there on the rig sitting around, send them here to the yard and we will let them piddle around here; but **we are not going to have any more lost-time accidents."**

Success?

The program gets underway with a big bang. The employees are excited and they talk it up. There is a lot of excitement created and they get a big bang out of receiving their gifts and awards. The family nights are a big success with large turnouts. Of course, some of those attending have an arm in a sling and others have bandaged heads and hands — but they are there.

Month after month goes by and still no lost-time accidents. The office force is going mad trying to keep up with who is eligible for what award and seeing that they are ordered and delivered. Officials of the company are keeping the road hot trying to attend all of the steak dinners. The insurance company is heaping on the praise — they're collecting a big premium every month and haven't paid anything but medical bills.

Finally, the first year under the new regime ends and the celebration really begins when Ol' Crown Block gets a refund check from the insurance company for $67,500. Of course, what he doesn't mention is that he paid a whopping premium of $120,000 and the insurance company only paid out $10,000 on medical expenses.

Most of you are familiar with the type restrospective insurance plan the Square Hole Drilling Company had. Basically, it is this simple. The insurance broker and the carrier get a flat 25 percent of the premium for underwriting the policy which, in this hypothetical case, was $30,000. The remaining $90,000 is set aside for payment of claims on a cost plus 15 percent basis. However, there is a minimum and maximum loss clause on this cost plus business of 25 percent and 135 percent. This means the insurance company is entitled to at least 25 percent of this $90,000, or $22,500, even if they pay no claims.

So actually what happened here was that excluding the initial $30,000, Mr. Hardrock paid the insurance company $22,500 to pay $10,000 medical expense. This policy also contains provisions for 3 premium and loss adjustments. One at the close of the policy year, one 6 months later and one 18 months later.

Certainly, you can't blame "Crown Block" for being elated over his $67,500 refund — that's a lot of money! But Mr. Hardrock has overlooked a little matter of how much money he spent getting this refund. When you consider how much the vacations, bonuses, and other incentives cost, plus slowed down operations due to working cripples, and the cost of extra labor to work in the cripples' place, he could easily have spent $70,000 getting back his $67,500.

An Untimely End

All of this elation in the Square Hole Drilling Company was short lived, however, because before the 18-month period of readjustments had expired, claims were being pressed and suits being filed by former employees who only a few months previously referred to their injuries as minor and are now referring to the same injuries as "grave and serious" resulting in "total and permanent disability." To make matters worse, Square Hole started having lost-time accidents — even by his own definition.

Something was wrong and Mr. Hardrock had every reason to be concerned. His incentive program that had worked perfectly for a year was now falling apart. He was desperate and sought the advice of friends — one of whom recommended a capable safety consultant to evaluate his problem and make recommendations.

It didn't take the consultant long to

Continued on page B-35

The Author

John P. Carpenter is director, industrial and public relations for The Offshore Company in Baton Rouge, Louisiana. For four years, he was personnel and safety director of the drilling division of Southern Production Company. With the creation of The Offshore Company from that department in 1955, Carpenter assumed the same title in the new organization.

Carpenter was graduated from the University of Arkansas in 1948 with a BS degree in education. He is a member of the Drilling Industry Society of Safety Engineers, the American Society of Safety Engineers, and the AAODC Safety Committee.

Incentive Programs

Safety Consciousness is the Result

Continued from page B-32

—including a long range program, a short range program and intermittent one-time deals.

Long Range Program

In the category of a long range program, we give our employees a week's paid vacation at the end of 12 months service and it is called a safety bonus vacation. This vacation is earned through the safety program alone as our company does not have a vacation plan as a personnel inducement. The employee earns this vacation by working safely and any contribution he may make toward an accident penalizes him part of his earned time. If he is directly responsible or has a bad record himself, the rules are such that he loses all his privileges and must start accumulating more time toward his vacation. This is accepted by the employees and they do not seem to think that they are being rewarded for being partially safe but seem to feel that they have made a grave mistake when they do something causing them to lose part of their vacation.

Short Range Program

In the short range classification, we give our crewmen six pairs of canvas work gloves along with their pay check every two weeks. So far as I know, our company is the only one making this award more than once a month. It is felt that since the same number of gloves and the same cost per month was involved under the plan we could have two safety reminders per month instead of one.

One-Time Promotion

We have found that one-time promotional deals can be very effective, will create a great deal of interest and often cost very little. Whenever it is felt that the safety program needs something to stir up general interest or create talk among our crews I try to come up with an unusual, stimulating program. So far these have taken the form of contests, surprise announcements, unexpected extra awards and unearned giveaways. This is where the personality of the safety man and his ability to keep his finger on the pulse of his safety program comes into play. I think the timing of this sort of incentive depends on being close to the man in the field and the ability to spot a laxness in safety interest before it becomes apparent in increased injury rates. This particular part of the safety incentives program is amazingly inexpensive in that many one-time promotions have cost nothing and a few have cost as much as $150.

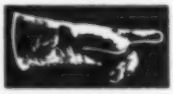
All in the Name of Safety

This in a nutshell is the incentive program Gardner Brothers uses, although we are always looking for other safety tools. On the strength of this experience in the use of incentives, here are a few recommendations that we've found that can make a program work and obtain maximum benefits.

1. Tie the program tightly to safety to be sure that maximum benefit is being derived from each award. Explain to employees that it is a savings sharing plan tied directly to safety and it is not a giveaway nor a bribe.
2. If an incentive program is under consideration for the first time or is a new phase of an incentive program, investigate and consider as many plans as possible. Be especially careful not to start something and then have it become necessary to stop. Start your awards as small as you can. If the award you pick is not satisfactory you can always come up to something bigger and better; it is almost impossible to cut them down to something smaller or less expensive.

Incentive, Continued on page B-36

Safety Incentive



PERSONNEL PROGRAM

Gloves — The fastest moving and most effective short range incentive program is the safety bonus gloves plan. Drillers and crewmen become eligible according to the following regulations:

1. The entire crew must have worked a full payroll period (14 days) without a lost time injury to any man on the crew.
2. Only those members of the crew that have worked the full 14 days will be eligible to receive gloves.
3. The individual injured in a lost time accident forfeits his gloves for two payroll periods.
4. Crews eligible will receive six pairs of gloves for each payroll period. Gloves will be delivered to the rig at the same time pay checks are distributed.

Vacations — All salaried field employees earn a regular vacation on the following basis:

1. 4 to 6 months service — 1 week vacation
2. Each month thereafter — 1 additional day vacation
3. Full 12 months service — 2 weeks vacation
4. Vacation pay is exactly the same as regular pay. (Miscellaneous hourly employees, such as truckers, welders, clerks, etc., are included in this category.)

Safety Bonus Vacations — Drillers and Roughnecks — In order to qualify for a paid vacation, each employee must have worked 12 consecutive months for Gardner Brothers Drilling Company without a lost time accident to himself. Any employee dismissed only because of rig shutdown will be given credit for his time and it will be applied to his accumulation of time providing he accumulates his 12 months working time within 24 calendar months. Provided he has the qualifications set forth above, each roughneck and driller will be entitled to one week (7 days) paid vacation subject to the following deductions:

For each lost time accident to a *fellow crew member* he will lose one day of his vacation.

All vacations must be applied for, approved, and taken within three months of the date on which the employee became eligible. By special dispensation, a vacation applied for and approved within three months may be deferred for men with children in school.

Employees resigning or dismissed for any reason other than rig shutdown will forfeit all rights to participate in this plan.

For purposes of computing the time necessary to earn a safety bonus vacation, the records will be kept and calculated from the day following any accident which

Their Fallacies

. . . But it is False Security

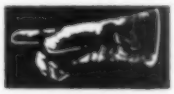
Continued from page B-33

survey the situation and get to the heart of the problem. Mr. Hardrock was dismayed and discouraged but to his credit he was sincere and ready to learn. The consultant's first step was to open Webster's Dictionary and read the definition given there of safety — "The quality of being devoid of whatever exposes one to danger or harm."

I won't attempt to give the consultant's report in full, but briefly this is what he told Mr. Hardrock. His program had failed because it was based entirely on superficial enthusiasm without a solid foundation. Much like a stimulant shot in the arm, it had created false sensations that soon wore off. Square Hole had not changed their policies and procedures and no effort was made to educate, engineer, and enforce for safety. This whole deal had been a big game. As a result, the novelty wore off, the honeymoon was over and Square Hole fell back into their same old rut.

All good stories have a happy ending and this one is no exception. Mr. Hardrock saw the light, employed a capable person to inaugurate and direct a safety program with a firm foundation, working at the basic principles of safety and doing a wonderful job of preventing accidents.

Before proceeding with the second session of this talk, I want to publicly announce that all names, events, situations, and statements were purely fictitious and any resemblance to persons, companies, corporations, situations or events was entirely coincidental.



. . . Or a Bribe

disqualified a crew member. That is, if a man loses his chance for a vacation he starts working toward it again the next day he is able to work.

In border lines or arbitrary cases, the drilling superintendent may submit the record to a board of two drillers and a toolpusher on another rig for a decision.

Vacations will not be given automatically — they must be applied for on a standard company vacation application form available in the district offices. They will be cleared through the Dallas office and returned to the drilling superintendent for final approval.

Crewmen awarded these vacations will be paid for a full week (56 hours) at regular rate of pay for the classification in which the *majority* of their vacation was earned.

Toolpushers — A toolpusher may qualify for a safety bonus vacation in addition to his regular vacation by having accumulated 12 months time as a pusher without lost time accident to any member of his crews. However, since it would work a hardship on the company to have a toolpusher off the job for a safety vacation in addition to his regular vacation, he will receive a credit equivalent to a one week paid vacation which he may take under one of several options. These are:

1. He may have the company buy him a gift of value equal to one week's pay (gun, camera, clothing, fishing gear, etc.).
2. He may take cash.
3. If he has less than two full weeks regular vacation coming he may add the safety vacation to his regular vacation to make up the full two weeks. Any additional time left will be taken under one of the other options.
4. He may take the week's vacation with pay only if the work in progress will warrant his absence for that length of time.

Bonus — The company has for many years followed the practice of giving salaried employees a yearly bonus at Christmas time. There is no fixed formula and amounts vary according to length of service and position held.

Safety Publication — Each month the company publishes a small leaflet with news of interest and safety items. It is named the "Scoreboard" and is aimed at giving the rigs crews "the score."

Inspections — The company has a very complete inspection sheet which is generally filled out by the safety director at irregular intervals. We feel this is very effective because drilling crews show great concern at any sort of "write-up" on their rig and the general rig conditions showed improvement as soon as these inspections were inaugurated.

Gimmicks — Our safety program is kept very flexible and we feel we do a lot of good with a sporadic program of unusual features. These are mostly in the form of contests with prizes ranging from an inspection trip on an expense account to turkeys for the crews of a winning rig.

Here's the Catch

Now without the benefit of any tall tales, I would like to discuss a list of what I consider the fallacies of incentive programs. These conclusions were deduced from experience with incentives in our own organizations and observing programs in other companies and discussing them with the people concerned.

When examined carefully and impartially under the true light of ethics, an incentive program impresses me as a socially acceptable form of bribery. It appears to me that we are bribing a man to do something that we have already paid him to do. Now some of you don't like the word bribery and my previous statement has not set well with you, so let's approach it from another angle — assuming that bribery is not the correct term.

Looking at it from the other angle, you employ a man as a driller for the standard wage and expect him to perform the duties of a driller; but apparently being safety conscious, preventing accidents, and maintaining a good safety record is not part of his regular duties or responsibilities and, because they are not part of his regular duties and responsibilities, you agree to pay him a bonus, give him a vacation, give him a prize, award, etc.

For those of you who don't like the bribery angle and don't agree that you are telling your employees that it isn't part of their regular duties to be safety conscious, let us try a third angle in picturing incentives in their true form.

Some of you may have a private plane and employ a pilot. Let us momentarily remove our evaluation of an incentive program from the drilling rig to the airplane. What kind of reaction do you think you would get from the pilot of your personal plane if you were to offer him a TV set if he flew the plane from Dallas to Los Angeles without crashing it. Ridiculous you say!

It is not so far-fetched, as the principle is the same in a drilling crew when you offer a reward, whether it be a belt buckle, wrist watch, savings bond or a vacation to a crew member; because, in effect, you are telling him that he knows better but is stupid enough to injure or kill himself and that if he will try real hard to overcome this natural desire to destroy himself and success-

Fallacies Continued on page B-36

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Incentive Programs

3. Squeeze all the possible benefit from each dollar spent. Advertise what you are doing and how it works in order to receive the maximum good from your investment.

Talk It Up!

Some other rules that may be included apply to a complete safety program as well as to the incentives part of it.

1. **Keep talking it up.** As long as you and your supervisors are talking safety it will be a constant thing that will always be in front of the man who needs it.
2. **Keep some new fresh approach going all the time.** Your ideas on promoting safety may be just as good as some you take from the National Safety Council or from someone else's program. Try to keep something unusual and active working for you at all times.
3. **Do anything you feel necessary to keep the interest** of the men who can do the job for you. The supervisors are the ones who can make the safety program and incentive program work.

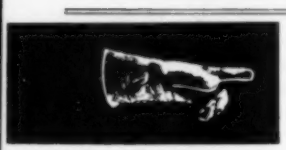
Get the Interest; Keep the Employee

I am not opposed to the old "tried and true" safety methods and I do not believe in replacing any of them but I do believe in dressing them up with a new and fresh approach as often as possible. One of the best ways to attract interest in these new and fresh ideas is to use incentives to gain the interest of the employees you wish to impress.

Incentive programs are working. Many of them are in existence. I firmly believe that many of them are doing a wonderful job.

They certainly have worked for me.

* * *



Their Fallacies

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fully do it for one year that you will give him a prize.

There Is Improvement

I would be foolish indeed to stand on this rostrum and deny the fact that many, many companies have shown a remarkable improvement in their safety record with the inauguration of incentive programs. I am well aware of this fact and have no intention of disputing it. However, I do want to question the apparent improvement on two points.

1. How much has the injury frequency and severity rates for disabling injuries actually improved when measured by the regulations set out by the American Standards Association, the National Safety Council and the American Petroleum Institute?
2. How much of this improvement is due to the incentives and how much is due to other forceful factors brought into play simultaneously with the incentive program, but not directly or indirectly related to the incentive program?

On the first point, it is common knowledge that many companies have their own definition of a lost-time injury and that such injuries as amputated fingers, broken arms and the like are carried as no lost-time injuries. I heard of an instance — and I can't authentically verify this — where a company ruled that a fatality was not a lost-time injury. It is also common knowledge that some men unable to perform their regular jobs are put on lighter jobs to keep them on the payroll. Others recover sufficiently on their days off to report on their regular hitch but were actually unable to perform their regular job the day following the injury.

Certainly any company has the right to adopt its own policies and the practice of computing frequency and severity rates by strict ASA regulations for submission to the National Safety Council and for comparison to other companies is obviously not necessary to run a good safety program. To me the important thing is for the individual company to have a true picture of their own experience and I personally don't see how they can get a true picture unless they use an authentic criteria and apply it to every case.

On the second point, in companies where no safety program has been in effect and an incentive program is inaugurated, it is usually the result of the problem being forcibly brought to the attention of the management.

While the incentive program is the only outward indication of a change, at the same time the attitude and outlook of management is changing. They are aware of the problem and are taking steps to do something about it. Policies and operations begin to change, equipment is maintained better, more thought and consideration is given to safety in all aspects of operations. The safety program then has the backing of management, and I think that this improves the safety record more than the give-aways to the workers and, furthermore, I don't think the incentives should get credit for it.

Falsification

Going down the list, incentives encourage the falsification of injury reports and the failure to report injuries. At first glance, a man so interested in his safety record that he will not report it and pays the medical bill himself is to be admired. On the other hand, he may not be doing you a favor and may not save you any money. A contractor who tolerates or openly encourages the reporting of a disabling injury as a minor injury would probably blow his top if he caught the driller "boilerhousing" the engine report or the drilling report. If he caught the driller hanging the straight hole survey instrument in the doghouse shooting a day's supply of charts at ½ deg when the hole was actually off 7 deg, he'd run the whole bunch off. I submit to you that there is no difference in principles in these cases — the only difference is the importance the contractor attaches to them.

Incentives tend to create an unhealthy attitude toward safety by leading them to believe that safety is the art of camouflaging disabling injuries and therefore some type of game completely unrelated and apart from their work.

In some instances incentives bring undue pressure to bear on individuals to continue working when they should be off work receiving medical attention. Sometimes this pressure is self-inflicted by the individual in an effort to protect his own safety record or that of his crew for some personal gain. In a case where the individual is faking

or exaggerating his complaints, pressure or threats from the crew may change his mind — but bear in mind the crew may be mistaken as to whether or not the complaint is genuine and this pressure or threat from the crew could place you in a very undesirable position.

Ex-Employee Wedge

Another facet of the incentive programs placing the company in a vulnerable position is that they provide disgruntled former employees with a good alibi when after being terminated they decide to file a claim on an injury that was never reported. This particular point is not hearsay, gentlemen, for I have experience in this matter.

In situations where a company subscribes to the theory that only litter cases are lost-time accidents as the result of an incentive program — that incentive program can lull the company into pulling the wool over their own eyes and very happily living under the false impression that their safety record is excellent, when, in reality, it is very bad.

Incentives foster the type of safety program that is best illustrated by the man whose lawn is infested with weeds and undesirable grasses. He gets out his rotary type mower and goes over the lawn, leaving it level and pretty — temporarily. The weeds and undesirable grasses are temporarily hard to distinguish — but they are still there. The type safety program needed is best illustrated by a man with a similar lawn who gets out his grubbing hoe and digs out the weeds and undesirable grasses by their roots.

Accidents are like weeds and undesirable grasses and that as long as we are satisfied with clipping the tops we are spinning our wheels. When and only when we get out our grubbing hoe and dig out the underlying causes of these accidents will we rid our operations of these undesirable roots.

Incentive vacations and bonuses often amount to kicking the man when he is down. The man who is uninjured can work regularly and is doing fine — so he gets the extra cash and a vacation. Poor Ol' Joe, who suffered a serious injury that wasn't necessarily his fault, is having a rough time getting by on his compensation and doesn't get the extra money. In an effort to make more persons eligible for the incentive benefits, especially drillers, the gap is let down to take care of a driller who is trying hard but has some lost-time accidents of a "minor" nature. This prompts a provision such as one I noticed in a program passed out here last year. It made the provision that the driller was eligible for his safety vacation if he had no more than 4 lost-time accidents in his crew for the year.

The Ridiculous

Such a departure is understandable, but let's see what has happened. The situation has been created whereby it is theoretically possible for a wild driller to go haywire — run into the crown, cut the line, kill all four of his roughnecks and tear up the rig. Then at the end of the year, you call Wild Bill in and say, "Son, we're proud of you. You drilled a year and only had four lost-time injuries. Unfortunately, all four of them were fatalities. But that's just one of those things. Take your safety vacation and have a good time. Here's hoping your record is as good next year."

Another twist to the incentive picture has been presented to me by some of our employees and their pitch was, "Why not give a driller a gift worth several hundred dollars if he goes a year without a lost-time accident. If he just had one man break a finger, the bill would be that much!" Now what kind of reasoning is that? Are drillers supposed to have accidents? If this is the kind of reasoning we're to use, perhaps we should pass out air-conditioned Cadillacs to drillers who go a year without pulling a derrick in — same principle.

I know that I have expressed opinions in direct conflict with many of you gentlemen more learned and experienced than I. Nevertheless my opinions, observations and recommendations were sincere and in good faith. Due to the controversial nature of the subject I want to set the record straight with regard to my opinions on some points.

First of all I am not opposed to steak dinners, banquets, barbecues or picnics for employees only or the entire family. I think such activities are wonderful and beneficial even when no safety meeting is held. My point is that when you limit them to rigs with good safety records you are excluding the people who would profit by it most.

On the subject of vacations, I think they are beneficial to both the employee and employer, and if I were a contractor I would make them available to all employees. My objection to tying them to safety records is that it is difficult if not impossible to administer such a plan without discriminating against some of your employees.

Recognition

Certainly I wholeheartedly endorse the practice of recognizing employees with outstanding safety records, but there is a distinct difference between recognition programs and incentive programs. The difference is comparable to that between a pat on the back following an accomplishment and waving money in the face of the individual to encourage him to accomplish the feat.

I would like to quote from a talk to the 1955 AAODC South Louisiana Safety Clinic by Max Clayton, manager of Shell Oil Company's Marine Production Division in New Orleans. His subject was "The Care, Maintenance, and Operation of Blowout Prevention Equipment." He made a statement that I remember quite vividly and it was, "Gentlemen, the answer to our problem is the selection, training, and placement of personnel."

I would like to transpose Clayton's statement and submit to you the proposition that the answer to all our safety problems is the selection, training, and placement of personnel and that an incentive program standing alone is a poor excuse for a safety program.

★ ★ ★

EDITOR'S NOTE: Incentive programs are being employed successfully by many drilling contractors to promote safety on their rigs. There are those, however, who have had less satisfactory results.

The controversy that has developed among those who are charged with the safety of drilling employees, concerning the value of these programs has triggered a double-barreled discussion at the recent Drilling Industry Safety Clinic in Dallas. Safety directors, representing two leading drilling contractors, presented their thoughts and experiences with safety incentive programs at the AAODC sponsored meeting.

Their arguments — pro and con — are presented here for your own consideration and evaluation. Although the controversy may not be resolved and a perfect program may not yet be found — safety consciousness has certainly been stimulated. So long as safety is **talked** — men will be safety minded. It is with this one thought in mind that THE PETROLEUM ENGINEER offers this discussion.

Development and field testing of

Wire-Line Retractable Rock Bits

Drilling costs can be reduced as much as 25 percent in a 7500 ft hole using this unique three-cone bit and surface equipment designed for casing drilling

J. M. Camp,
J. E. Ortloff,
and R. H. Blood
Research Department,
The Carter Oil Company,
Tulsa, Oklahoma

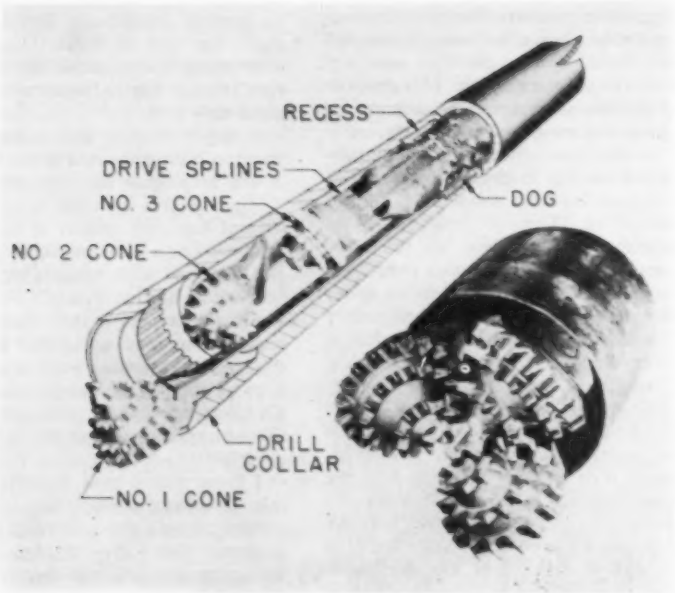

FIG. 1. **Three-cone retractable bit,** was the more successful of the two types tested. Cutaway shows cones sliding into position in the specially constructed drill collar. Second photo shows the bit in drilling position. The bit cuts a 9¾-in. hole, and 7-in. streamlined casing is used as the drillstem.

RECENT favorable tests using two types of retractable rock bits suggest a fresh approach to reduce ever-increasing drilling costs. Although the retractable bit idea is not new, field tests have proved the bits mechanically sound and substantial progress has been made toward manufacture.

A four-cutter and a three-cone bit have been developed. The four-cutter retractable bit was tested first and found sound, but compared with conventional bits its drilling rate and bit life were not satisfactory.

A three-cone bit, still lacking minor adjustments, has been developed with a drilling rate comparable with conventional tri-cones. The life of this bit is 90 percent of conventional bits. Based on this performance and with surface equipment designed for casing drilling, drilling costs can be reduced by perhaps as much as 25 percent in a 7500 ft hole.

Old Ideas — New Approach

Drilling with casing and collapsible drag bits is not broadly new. Before muds were developed to control heaving shales, this method was used in penetrating such shales in the Gulf Coast and East Texas. This early casing drilling permitted shale sections to be penetrated without pulling pipe to change bits, the casing being carried to total depth and cemented in place.

Drilling with casing and retractable rock bits was analyzed to see if drilling costs could be reduced by this method. Estimated costs of retractable bit drilling were compared with costs of standard rotary drilling in 7500-ft Mid-Continent wells, and savings up to 25 percent of conventional drilling costs* were indicated. Fig. 2 shows the estimated cost of drilling with casing as a percent of conventional drilling cost when related to various drilling rates and lengths of bit life for retractable bits. The predicted savings for casing drilling were based on reductions in time, equipment, investment, and labor resulting from the elimination of trips with drill pipe to change bits. Reduced equipment investment is considered possible because the need for high-powered, high-speed hoisting equipment to make rapid round trips is eliminated. The only equipment required is that for adding single stands of pipe or for handling occasional emergency pulling operations at slow speed.

In the drilling system analyzed, 7-in. OD streamlined casing was selected for the drill string. Two retractable rock bit designs were considered — a four-cone, and a three-cone. The bits pass in a collapsed position through the casing bore and then expand to cut a hole large enough (9¾-in. diameter) to pass the casing. The bits are transported in and out of the hole by a swabbing or sand line.

Since round trips with pipe are not required, it was assumed that the mast for adding single casing joints would be

Original paper presented at the ASME Petroleum Mechanical Engineering Conference in Tulsa, Oklahoma, September 22-25, 1957.

*The term "drilling costs," as used in this paper, refers to the penetration (or contractor's) portion of total well costs.

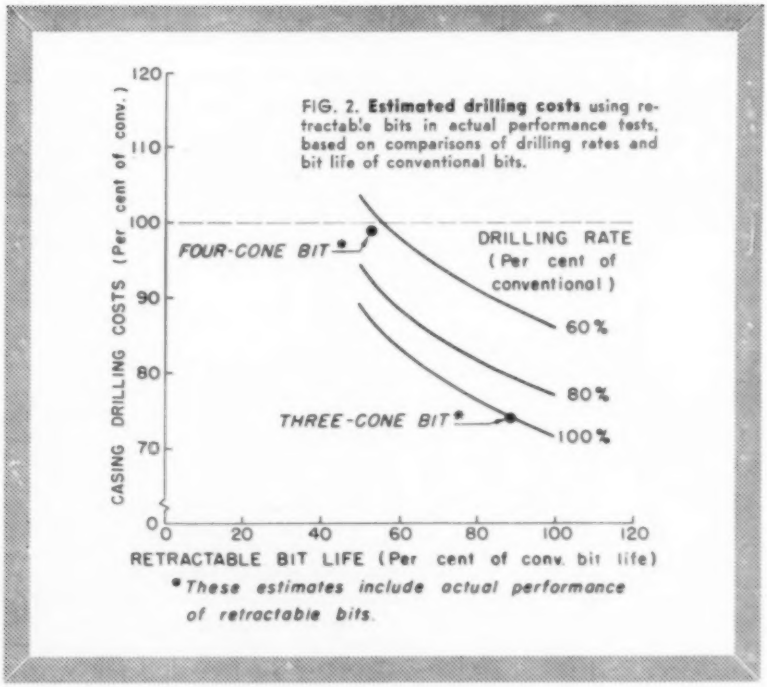

FIG. 2. **Estimated drilling costs** using retractable bits in actual performance tests, based on comparisons of drilling rates and bit life of conventional bits.

shorter than standard height, and that less hoisting power would be required. One crewman would be eliminated. Rotation and circulation would be conventional except that a special casing drive would replace the standard rotary kelly and bushing.

Development of a four-cone retractable bit was started first, and later the three-cone bit was built.

Operation of the Four-Cone Bit

The four-cone bit was designed to carry the collapsed cutters in pairs for making round trips. Fig. 3 shows the special drill collar receiving the bit. When the two spring dogs contact a shoulder near the bottom of the drill collar, they stop the downward movement of the two center cutters.

A sinker bar at the top of the bit pushes the two hinged outer cutters against a wedge (supported by the dogs) and the wedge in turn forces the outer cutters to gage diameter. At the same time the heavy spring is compressed and the upper latching dogs are carried past a downward-facing shoulder near the upper end of the bit assembly. A seal is expanded to fit the bore of the drill collar. The overshot, which is attached to the cable, is released from the bit spearhead when a tripping sleeve is dropped down the cable from the surface. The cable is then reeled from the well.

The casing is lowered until the bit reaches bottom and the upper dogs carry the drilling weight as shown in Fig. 4. A drive lug, extending downward from the upper shoulder transmits drilling torque through one of the upper dogs to rotate the bit.

Mud coming down the casing bore is diverted by the seal through ports and down the center of the bit body. The stream is divided into two jets which strike the bottom of the well between the outer and inner cones.

Worn-out bits are replaced by reversing the above procedure. The casing is picked up enough to permit the surface connection to be broken and the pipe to be hung in the slips. The cable and overshot are lowered over the spearhead and the collapsed bit is pulled to the surface.

Operation of the Three-Cone Bit

The three-cone bit was designed to use the largest cones that could possibly pass through the bore of the casing. To do this, the cones are arranged in single file when the bit is collapsed. Fig. 1 shows the bit collapsed in a cut-away view of the special drill collar designed to receive the bit. Also in Fig. 1 the bit is shown expanded to full drilling diameter.

The bit is lowered on a cable and special overshot through the casing. Each cone is stopped successively by contact of separate spring-loaded dogs in the locking recess. Thus all three cones are positioned at the lower end of the drill collar. The heavy central mandrel (to which the cone carriers are slidably attached) continues downward to wedge the cone legs outward against the lower end of the drill collar bore. Corrugations (or splines) in the casing bore engage the outside of the cone legs to transmit torque directly from the drill collar to the bit. Thus a direct method is provided for driving the three-cone retractable bit. For the four-cone bit, dogs transmit torque and weight into the mandrel several feet above the cutters.

An expanding packer is held down by two latching dogs (not shown in the figure) near the upper end of the bit assembly. The packer diverts drilling mud through the bore of the mandrel and out through a nozzle at the lower end. The fluid jets the bottom of the hole slightly off center.

The overshot will not release the bit spearhead until the upper dogs are seated in the recess of the drill collar.

Tests

The four-cone bit was field tested five times, and drilled a total of 1142 ft of hole. Modifications were made as weaknesses showed up during the course of the field tests. Some of the major difficulties were sand deposit and

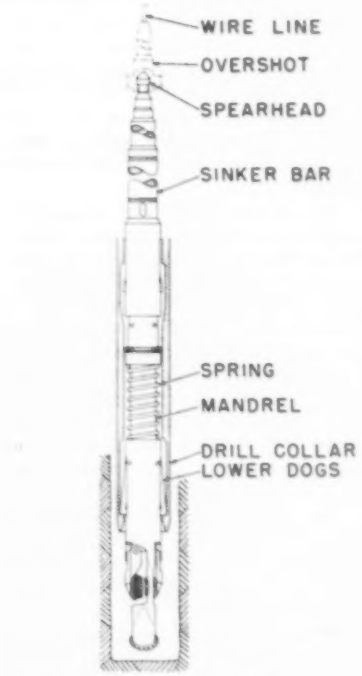

FIG. 3. **Four-cone retractable bits** carry collapsed cones in pairs. Sinker bar near the top forces cutters against wedge to expand cutters to gage diameter. Bit is removed by running overshot in on wire line, tripping overshot sleeve over spearhead and reeling from well.

sand erosion near the seal, nozzle erosion, inability to ream undersize hole and tool joint weakness in the mandrel. With these defects corrected the retraction and expansion of the bit became quite reliable.

During most of the tests drilling weights and rotating speeds were about the same as those for conventional drilling in the test areas near Seminole, Oklahoma.

Table 1 shows the average drilling rate and average bit life of the four-cone bits for each field test. These are expressed in percent of conventional bit performance in the same area.

Table 1.

Test	Field	Average Drilling Rate (% of Conventional)	Average Footage (% of Conventional)
1	Searight	90	66
2*	N. W. Perry	—	—
3	Seminole	55	53
4	Konawa	67	36
5	Seminole	41	46
	TOTAL AVG.	65	55

*Insufficient hole was drilled during this test to determine comparative drilling rate and bit life.

The generally low performance level of the four-cone bit was the result of the small size of the cones as compared with that of standard bit cones for the same 9¾-in. hole size. The cutter size determines the size and load capacity of bearings, the number and size of teeth, and the strength of the cone shell. Thus unit load and resultant wear are higher per tooth in the smaller cones.

The three-cone bit was laboratory-tested by the bit manufacturer before field drilling tests were made. In these tests the bit was compared with conventional tricone bits, both being run in the same rock and at the same weight and speed. Drilling rates were equal. In a bearing life test, run on a steel block in drilling mud, the retractable bit ran at 60 rpm for 45 hours at loads that totaled 657.5 ton-hours. Broken and damaged bearings in two of the cones stopped the bearing life test.

The three-cone bit was field-tested twice near Seminole, Oklahoma, during which 421 ft of hole were drilled at rotary speeds and drilling weights commonly used in the area.

Mechanical trouble occurred mostly with the expansion of the bit. In one instance the third cone would not go entirely into drilling position because the casing was lying against one side of the hole. This prevented proper expansion of the first two cutters to make room for the third. Suitable centralizers were added to correct this trouble. In a later test one of the positioning dogs passed the drill collar recess and the cone protruded below the other two

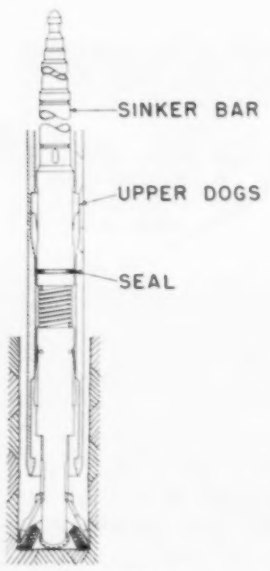

FIG. 4. **Retractable bit** in drilling position. Mud is circulated down the center of the bit body and divided into two jets, striking the bottom between the inner and outer cones.

cones. When the bit was set on bottom and rotated, the cone and carrier were damaged. Later trials in the drilling laboratory showed this trouble to be caused by a dash-pot action that retarded the movement of the positioning dog. This difficulty was readily remedied.

Table 2 shows the average drilling rate and bit life of the three-cone bit, calculated from field tests. Again, these are shown as percent of conventional bit performance in the same area.

Table 2.

Test	Field	Average Drilling Rate (% of Conventional)	Average Footage* (% of Conventional)
1	North Earlsboro	102	92
2	Seminole	120	87
	Average	111	89

*Based on engineers' estimates of partially worn retractable bits.

As shown in the table, the three-cone retractable bit performance compares very favorably with that of conventional tricone bits. This is attributed to the relatively large size of the cones in this model, which approach conventional cone size. Although a slightly higher drilling rate was recorded, the amount of hole drilled was limited. The drilling rate is therefore considered equal to conventional.

Status of Development

It was felt that after having proved field operability, any further development could be done more efficiently by an organization equipped for specialized machining and metallurgy work. Both retractable bit designs have been licensed to a major bit manufacturer on a nonexclusive basis.

Additional Applications

Economic analysis of retractable bits as shown in Fig. 1 was based mainly on their use as a means of drilling wells to producing depths without the time loss of round trips or the costly rigs necessary for frequent trips. Also, conventional hole size and essentially conventional practice were assumed.

Several extended uses have been suggested. Drilling down surface casing in areas of caving surface formation is one. Slim hole drilling with nonroller cutter retractable bits (to eliminate the bearing problem) is another. Retractable diamond bit cutters are a possibility. Another possible field of use is in conjunction with reelable downhole powered drills driven by fluid power, electrical energy or otherwise.

Test Results

Economic studies based on conventional Mid-Continent well costs indicate that the three-cone retractable bit, under proper conditions, could save about 25 percent of penetration costs in 7500-ft drilling.

The savings to be expected from drilling with casing should increase with depth, because trip time increases. In wells shallower than about 4500 ft the streamlined drill casing must be replaced by cheaper API casing to save money.

The development work done so far has produced reasonably workable bits that stand a good chance of practical usage. To fully realize the economic benefits of drilling with casing, surface equipment should be tailored for the purpose.

Acknowledgments

Appreciation is expressed by the authors to The Carter Oil Company for permission to publish this paper on the basis of a company research project. The contributions of research engineers A. B. Hildebrandt, J. M. Kellner, and W. A. Freeman are also acknowledged.

The Hughes Tool Company and the Houston Oil Field Materials Company, Inc., extended excellent cooperation in the design and manufacture of components of the retractable bits. ★ ★ ★

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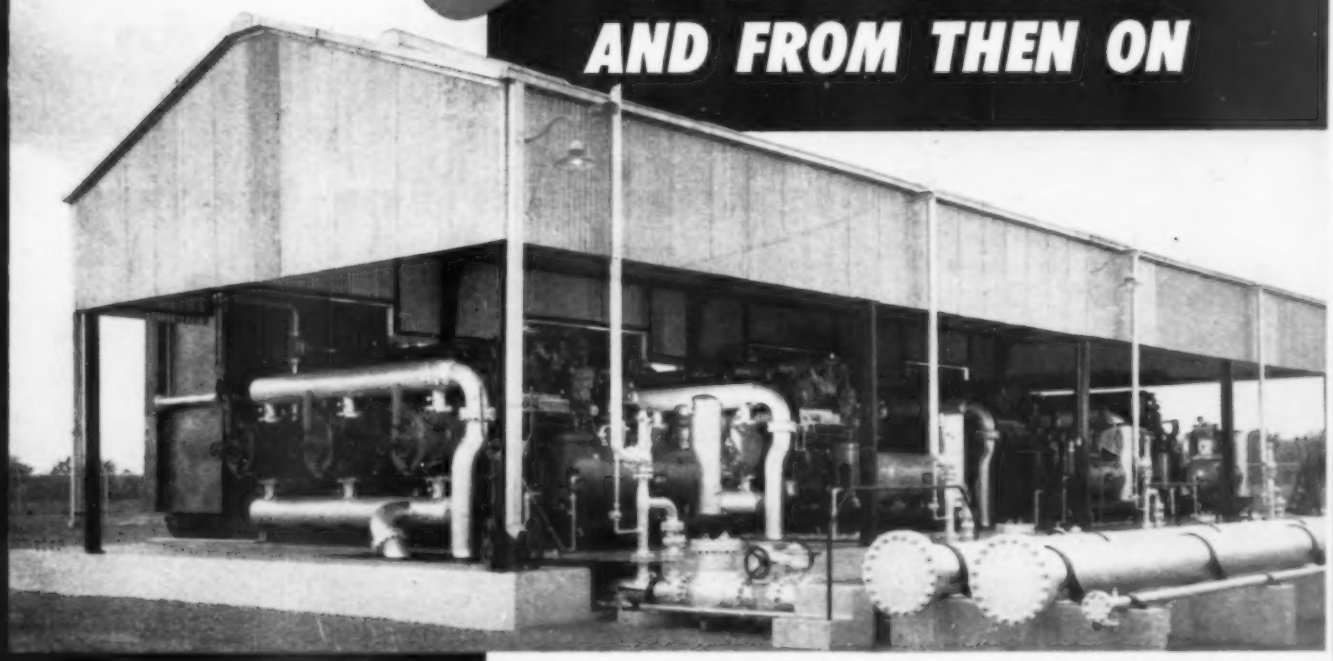

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Problems in Drilling a Deep Slim Hole

Victor R. Williams
Mobil Overseas Oil Company, Inc.
Abadan, South Iran

A small rig, fast penetration and small casing trimmed $27,000 off the high cost of a 9160-ft Oklahoma well in spite of lost circulation, a downhole fire, 10 days reaming time, fishing and sidetracking the hole

SAVINGS from slim hole drilling and experience gained by experimenting with various circulation media served to offset the high cost of drilling Magnolia Petroleum Company's Mildred Stull No. 1. Located in the Whiskey Creek field of Carter County, Oklahoma, the well was selected for a small diameter test in an attempt to cut high drilling costs in the area.

Williams was formerly in the drilling engineering section, Magnolia Petroleum Company, Oklahoma City, Oklahoma.

In the course of drilling this well to completion depth, several hole problems were encountered: Since the well was unique in size for this area, it was only fitting that methods to combat the problems would be unique.

Lost circulation zones, 8600 ft of small intermediate casing, a downhole fire, small junk in the hole, additional loss of drill collars, several squeeze cement jobs at various depths for various reasons, and sidetracking the hole — all these created special situations that called for special remedies. Portions of the well were drilled with inverted emulsion mud; sections were drilled with air and gas; use of aerated mud was attempted. From this was developed custom equipment and a unique drilling rig layout for drilling with various circulation media.

From the experience gained, it has been suggested that success warranted a second slim hole test, due to drilling performance and economic gains on the Mildred Stull No. 1 to 8600 ft, or

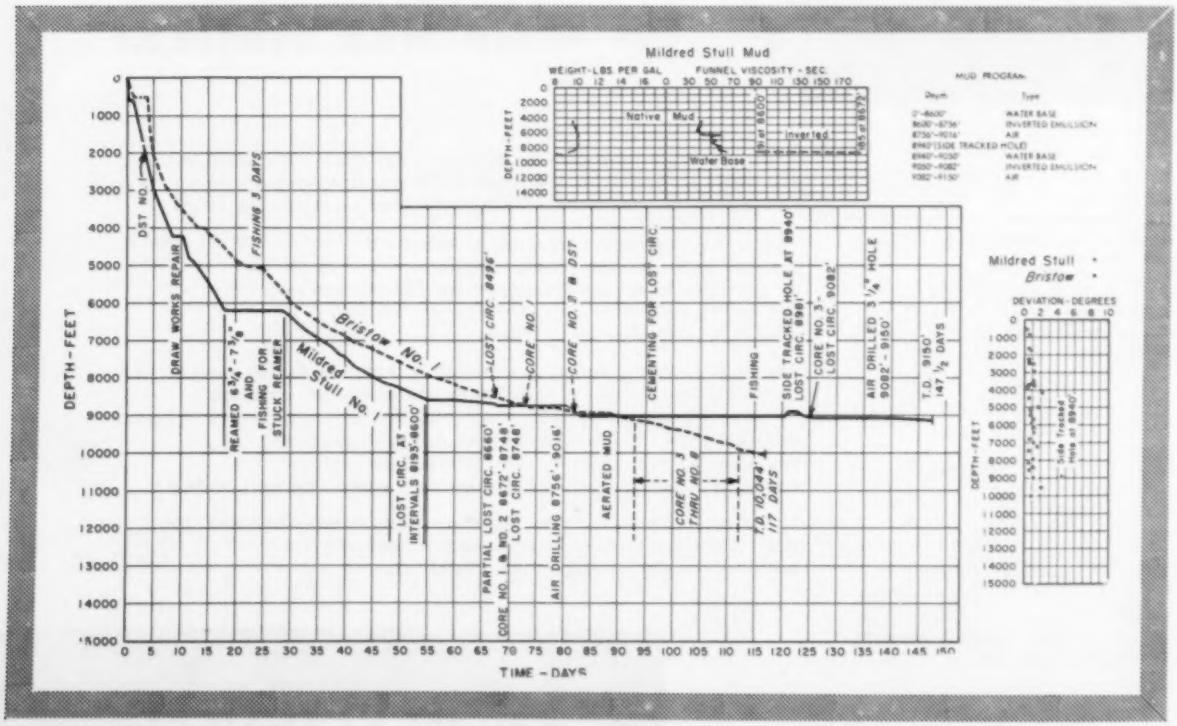

FIG. 1. **Comparison of drilling progress** of the Mildred Stull No. 1 and the Alice Bristow No. 1, diagonal offset wells in the Whiskey Creek field of Oklahoma. The Stull well was drilled "slim hole" using several fluid circulation systems. The Bristow well was drilled using conventional mud system common to the area and was of conventional hole size.

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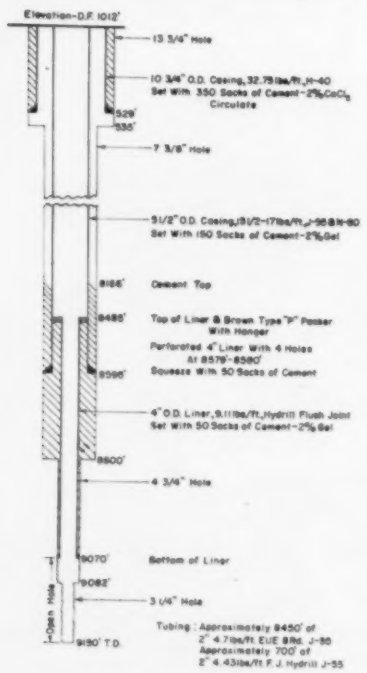
Elevation-D.F. 1012'
13 3/4" Hole
10 3/4" O.D. Casing, 32.75 lbs/ft, H-40
Set With 350 Sacks of Cement - 2% CaCl2
Circulate
529'
535'
7 3/8" Hole
5 1/2" O.D. Casing, 23/2-17 lbs/ft, J-55 & N-80
Set With 150 Sacks of Cement - 2% Gel
8186' Cement Top
8485' Top of Liner & Brown Type "P" Packer With Hanger
Perforated 4" Liner With 4 Holes At 8579'-8580'
8590' Squeeze With 50 Sacks of Cement
4" O.D. Liner, 9.11 lbs/ft, Hydrill Flush Joint
Set With 50 Sacks of Cement - 2% Gel
8600'
4 3/4" Hole
9070' Bottom of Liner
9082'
3 1/4" Hole
Open Hole
9150' T.D.
Tubing: Approximately 8450' of 2" 4.7 lbs/ft EUE 8 Rd. J-55
Approximately 700' of 2" 4.43 lbs/ft F. J. Hydrill J-55

FIG. 2. **Hole size and casing program** of the Mildred Stull No. 1. Well was originally completed in the Springer formation in open hole.

intermediate casing depth. It has also been recommended that use of air should be considered on other wells drilled by Magnolia's Oklahoma division.

Rig Choice

The Mildred Stull No. 1 was spudded on March 5, 1956, as a slim hole test and was evaluated by comparing performance and costs with Magnolia's No. 1 Alice Bristow, a regular sized hole and a northwest diagonal offset to the Stull well. It was estimated that 27 percent of the Bristow costs would be saved on the Stull well.

This economic gain was based on the use of a smaller, less expensive rig than used on Alice Bristow No. 1, and it was felt that a change in the bit program would reduce rig operating cost in comparison with the Alice Bristow. At that time, there were insufficient data on slim holes to compare penetration rates with regular size holes, and drilling time of slim hole was estimated to be the same as that of the regular hole.

The Mildred Stull No. 1 was drilled by Magnolia's Rig 36, having a rated depth capacity of 7000 ft with 4½-in. drill pipe or 8500 ft with 3½-in. drill pipe. Total power available to drawworks was 480-hp from two 240-hp diesel engines. Main slush pump had a 250-hp input rating with 7¼ by 15-in. stroke; auxiliary pump had 150-hp input with 7¼ by 12-in. stroke.

The Stull's "sister" well was drilled with a rig rated for 15,000-ft drilling with 4½-in. drill pipe and 18,000 ft with 3½-in. drill pipe.

Drilling Below Surface Casing

The well was first drilled to a depth of 600 ft, cutting 9-in. hole using 4½-in. drill pipe. The hole was then reamed to 13¾-in. to a depth of 535 ft and 529 ft of 10¾-in. casing was set with 350 sacks of cement.

Drilling below the surface casing with a 6¾-in. bit and 3½-in. drill pipe began two days later. Drilling was conducted without incident to a depth of 6186 ft.

Drilling comparisons between the Stull and Bristow were tabulated at intervals of 2000 ft. In all instances, penetration rate was faster, with decreased rotating hours, faster trips, less maintenance and less down time than that of the Bristow. Well deviation on both wells was less than 1½ deg. Since no record of pump operation was made while drilling Bristow No. 1, it was assumed that annular velocity was the same, and that the increased penetration could be attributed mainly to heavier bit weight per unit area.

Applied bit weight in the slim hole averaged 18,000 lb, while the average applied bit weight in the 9⅞-in. hole

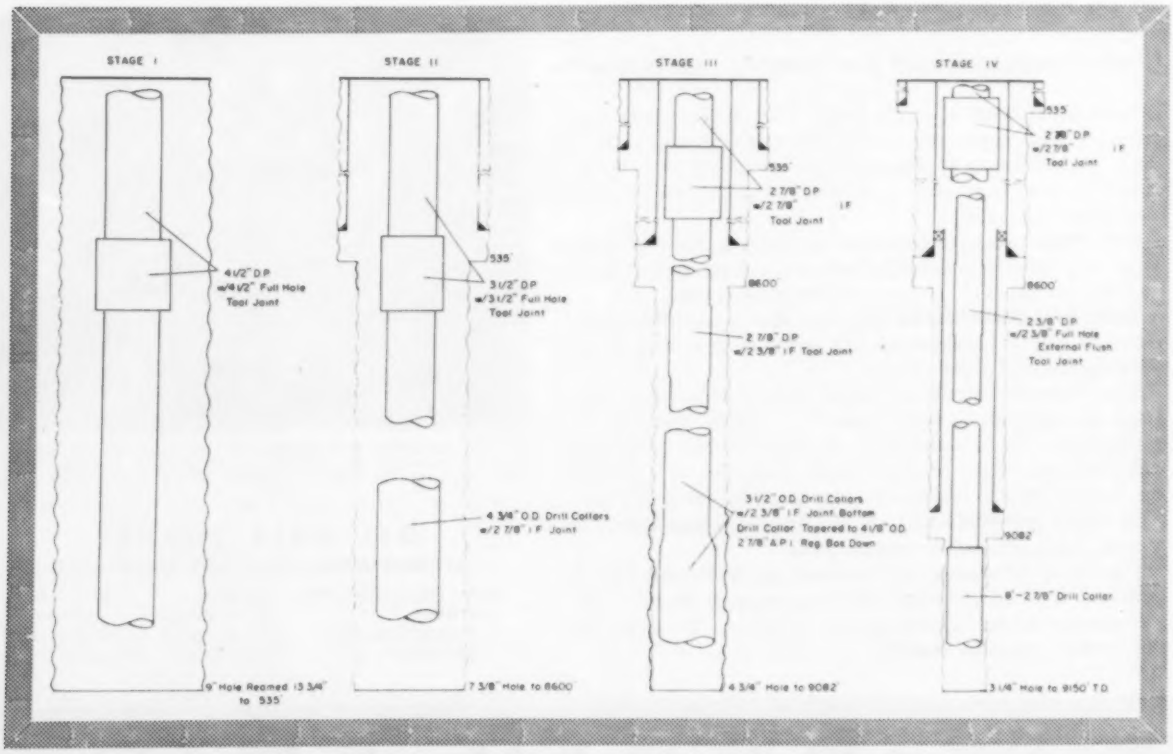
STAGE I
STAGE II
STAGE III
STAGE IV
4 1/2" D.P. w/4 1/2" Full Hole Tool Joint
535'
3 1/2" D.P. w/3 1/2" Full Hole Tool Joint
2 7/8" D.P. w/2 7/8" I.F. Tool Joint
8600'
2 7/8" D.P. w/2 3/8" I.F. Tool Joint
4 3/4" O.D. Drill Collars w/2 7/8" I.F. Joint
3 1/2" O.D. Drill Collars w/2 3/8" I.F. Joint Bottom Drill Collar Tapered to 4 1/8" O.D. 2 7/8" A.P.I. Reg. Box Down
2 3/8" D.P. w/2 3/8" Full Hole External Flush Tool Joint
9082'
8' - 2 7/8" Drill Collar
9" Hole Reamed 13 3/4" to 535'
7 3/8" Hole to 8600'
4 3/4" Hole to 9082'
3 1/4" Hole to 9150' T.D.

FIG. 3. **Drilling stages and drill stem design** of the Mildred Stull. In stage III, two different tool joint sizes were run. In stage IV, two sizes of drill pipe were used.

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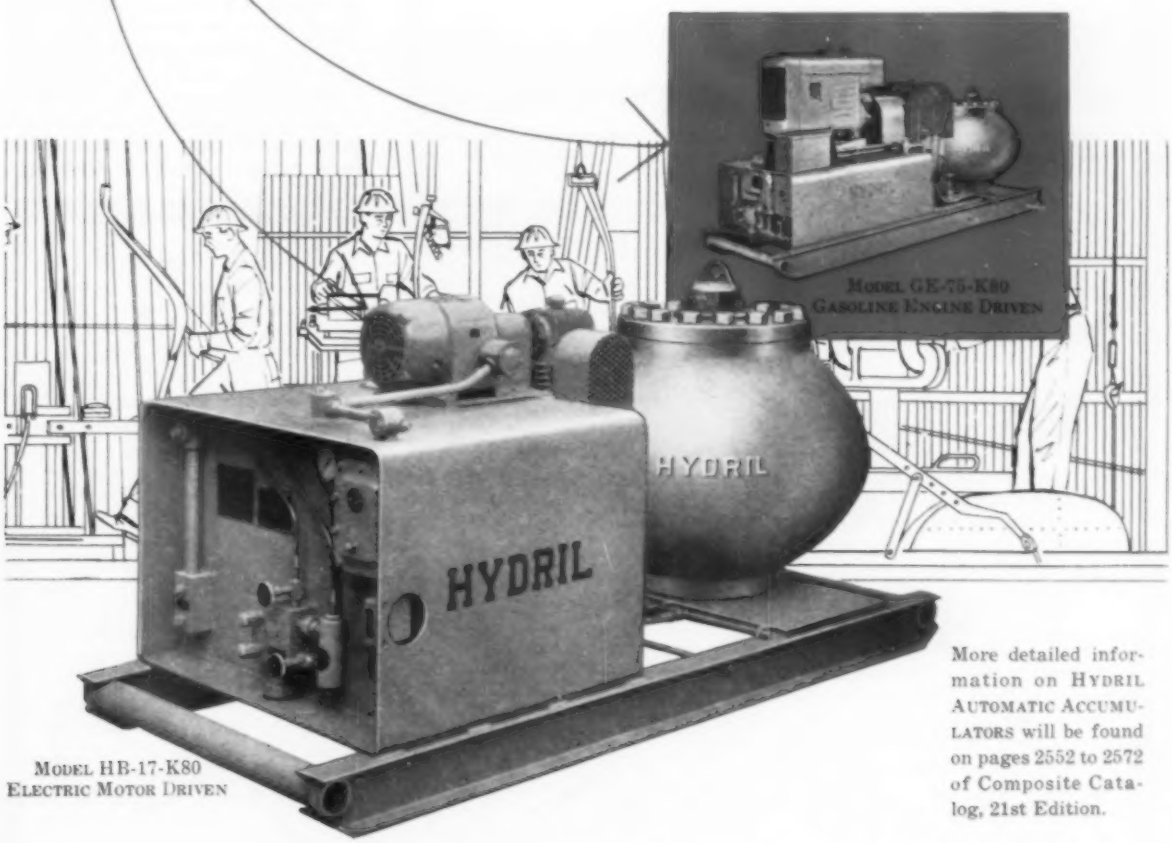

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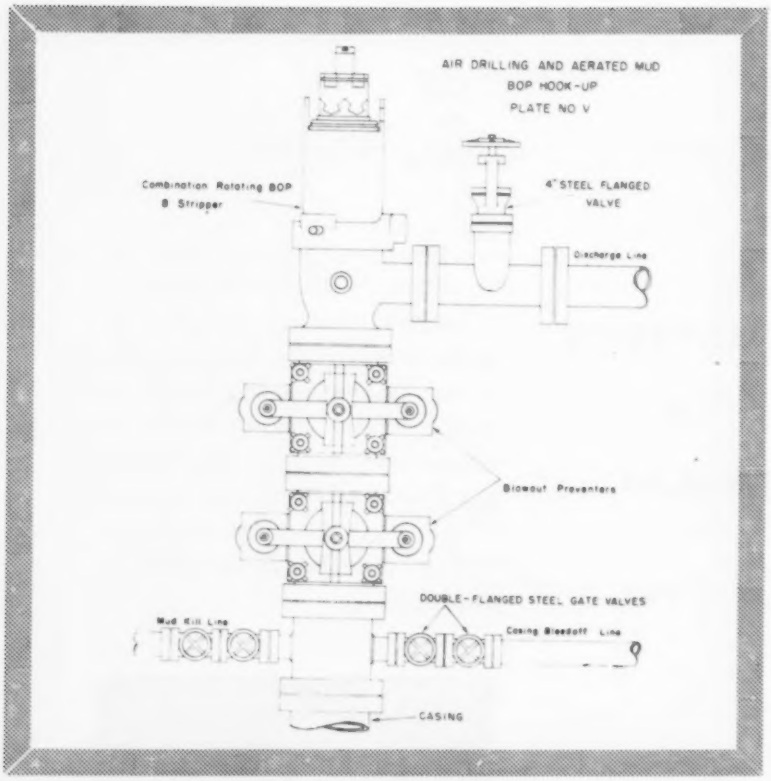

FIG. 4. **Air drilling and aerated mud** blowout preventer hookup, as shown here, required additional rig substructure clearance. The 9 ft substructure was replaced with a 14 ft substructure before beginning the air drilling phase of operation.

was 20,000 lb. The annular area in the 6¾-in. hole was 26.2 sq in. and the annular area in the Bristow's 9⅞-in. hole was 60.7 sq in. This placed a bit weight per unit area of 502 psi in the small diameter hole and 261 psi in the larger hole.

In the 2000 to 4000-ft interval, the slim hole was drilled 84 percent faster than the regular hole. Average feet drilled per rotating hour in the Stull was 23.4; in the Bristow, 15.2 ft per rotating hour.

In the 4000 to 6000-ft interval, rotating time was 110 hours less and overall penetration rate was 90 percent faster on the Stull No. 1 than on the Bristow No. 1. As there was no record of bit weight applied on the Bristow through this interval, an evaluation was impossible to account for the large gain shown in drilling the slim hole. Rotary speed on the Stull at this interval was 90 rpm and footage drilled per rotating hour was 15.9. In the comparison well, an average of 8.7 ft per rotating hour was drilled.

After reaching 6186 ft on the Mildred Stull, it was decided that the hole should be reamed from 6¾-in. to 7⅞-in. to provide more clearance for running 5½-in. casing. Original plans called for casing, with 6-in. OD collars, to be run in the 6¾-in. hole, as had been done successfully in several deep wells drilled in southern and western

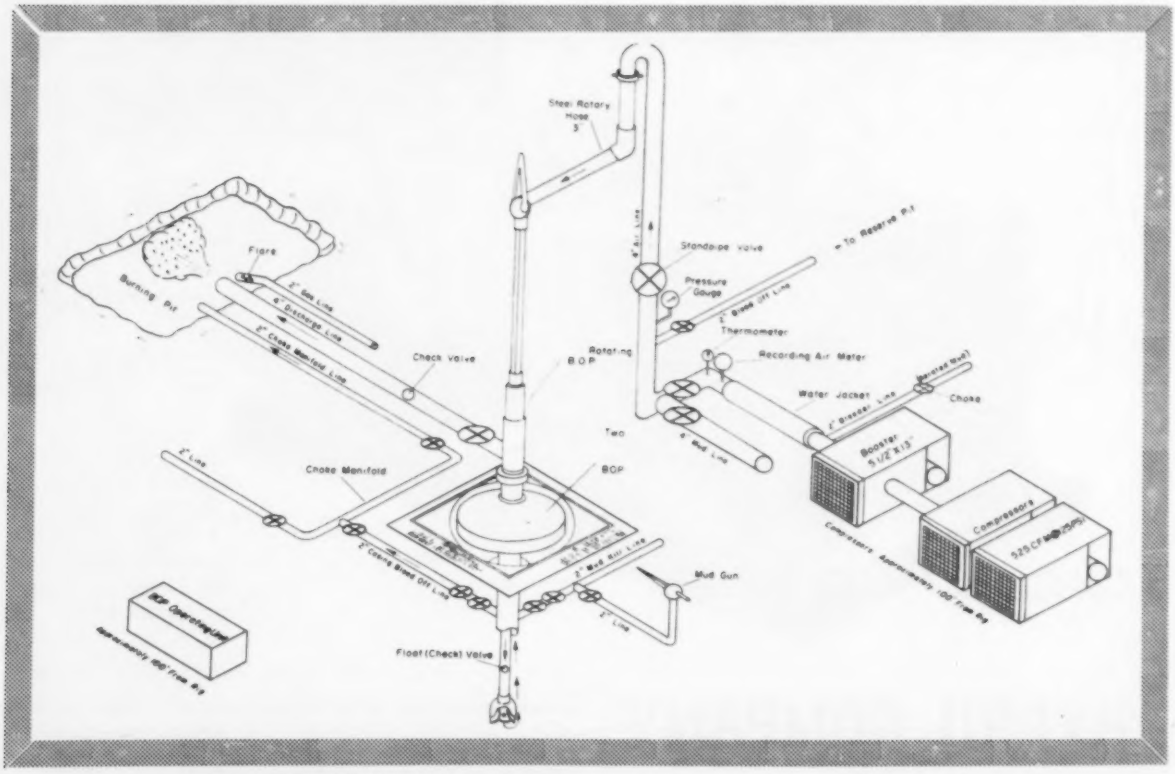

FIG. 5. **Complete circulation hookup** changeover was necessary before air drilling could begin. Air was first introduced in the Stull well as a circulating medium at a depth of 8748 ft.

FIG. 6. **Discharge, pilot and choked casing bleedoff** lines ended in a burning pit about 300 ft from the well. In the foreground is the choke manifold.

Oklahoma. Ten and a quarter days were required to enlarge the hole to 7⅜-in. The reamer was stuck during this operation and had to be washed over with diamond drills. Approximately 4¼ days were lost fishing for the reamer.

The Mildred Stull was drilled with 7⅜-in. bits from 6186 to 8600 ft, the designated intermediate casing point, with an overall penetration rate 54 percent faster on slim hole than the Alice Bristow. Average bit weight applied in this interval was 25,000 lb, increased to compensate for additional hole area. The Stull well was drilled with native mud to approximately 4200 ft, and followed by water-base mud to 8600 ft. In the 6186-8600-ft interval, partial lost circulation was encountered on both the Mildred Stull and the Alice Bristow.

A depth of 8600 ft was reached on Mildred Stull in 55½ days from spud date. The Bristow reached intermediate casing depth of 8775 ft in 74½ days after spudding-in. Several joints of 5½-in. casing were damaged in the slip area while being run on the Mildred Stull and a loss of time resulted from pulling the damaged pipe and waiting for replacement casing.

A string of 5½-in. intermediate casing was set at 8595 ft on Mildred Stull and 7⅝-in. intermediate casing was set at 8770 ft on the Alice Bristow. (Fig. 2.)

Below Intermediate Casing

A complete changeover in drilling format was made in drilling below the intermediate casing point. Fresh water-base mud was displaced with water-in-oil emulsion type mud. This mud was used to protect Springer sands which are susceptible to water damage.

At this point, 3½-in. drill pipe was laid down and 2⅞-in. drill pipe picked up.

Drilling in the 4¾-in. hole below intermediate casing on the Mildred Stull began on May 6. Although drilling progress was relatively slow, it was generally satisfactory until circulation was lost while coring at 8748 ft. Although geological formations encountered below the intermediate casing were not exactly the same between the two wells, a drilling time comparison in similar intervals showed almost identical progress. In the Stull, 148 ft of hole was drilled in 109.5 rotating hours for an average of 1.35 ft per rotating hour. In the Bristow, 141 ft was drilled in 102 rotating hours for an average 1.38 ft per each rotating hour.

Water-in-oil emulsion mud was used on both wells and very little difference in drilling rates was noted between Stull No. 1 and Bristow No. 1. Although the interval considered was hard, the difference in hole size apparently had little effect on penetration rates and 10,000 lb of bit weight did not damage the 4¾-in. bits used on Mildred Stull. Applied bit weight per square inch was practically the same on Stull No. 1 while drilling the 4¾-in. hole as it was while drilling the 6¾-in. and 7⅜-in. hole prior to setting intermediate casing.

Lost Circulation (8748-8756 ft)

Complete circulation was lost at 8748 ft on May 13, while coring in the 4¾-in. hole with a 3½-in. OD core barrel. This was in the Springer sand topped at 8747 ft. Since no reservoir information was available on this zone, decision was to core ahead. Prior to losing returns, the mud system had been pre-treated with light lost circulation material at the rate of 3 lb per bbl. Coring had begun at 8691 ft and the core barrel was pulled with a core recovery of 57 ft. After this point, the hole was deepened with little or no circulation, although mud weight had increased considerably.

From May 15 through May 17, the hole was deepened from 8749 to 8756 ft using both diamond and rock bits. Batches of mud with as much as 28 lb per bbl of lost circulation material were used in an attempt to regain circulation, while using approximately 1500 bbl of inverted emulsion mud. Lost circulation material used included walnut hulls, cellophane, mica, "leather-fiber," cane fibers, cottonseed hulls and other fibrous material. A total of 20,455 lb of material was used through this interval. Mud weight was maintained from 8.2 to 8.35 lb per gal, and funnel viscosity was 79 to 111 sec per qt.

Some difficulty was experienced with the slush pumps while pumping mud with large amounts of lost circulation material. Both pumps frequently lost their prime, making it necessary to remove and clean the valves.

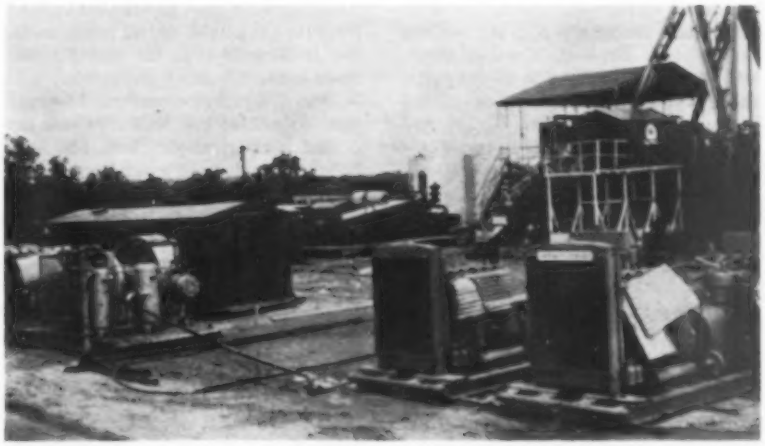

FIG. 7. **Two air compressors and booster unit** were used to air drill 356 ft of hole in the Mildred Stull No. 1. Air drilled sections were from 8748 to 9016 ft and from 9082 to 9150 ft. More than 200 ft of hole was air drilled even though salt water was entering the hole.

Air Drilling (8756-9016 ft)

After attempts to remedy the lost circulation failed, it was decided that drilling in the 4¾-in. hole would continue with air as the circulating medium. Mud in the hole was unloaded with air and gas pressure. The well made natural gas through the drill stem at a measured rate of 3,000,000 cu ft

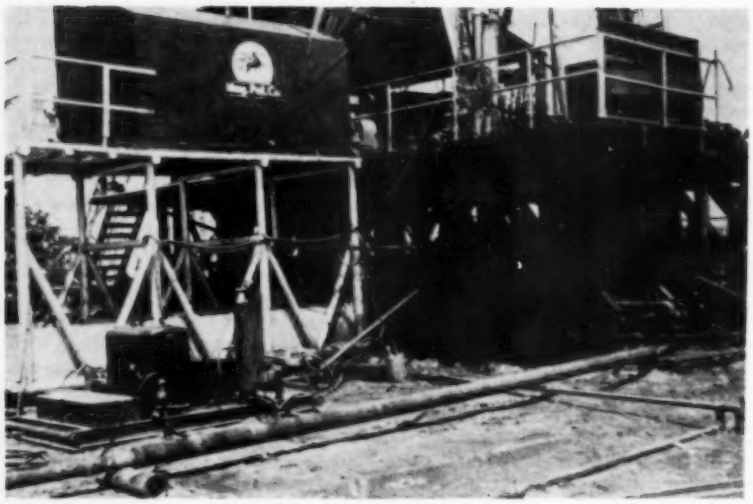

FIG. 8. **Drilling air was cooled** by a water jacket enclosing the air injection line between the booster and standpipe. Behind the line is the operating unit for power tongs used on 2⅞-in. drill pipe.

per day. Total depth at this time was 8756 ft. The well was killed and rigged up for air drilling.

Changes necessary for air drilling were several. The derrick and substructure were raised from 9 to 14 ft to provide adequate clearance for added blowout preventers. (See Fig. 4 and 5.) Provisions were made to run water through the drawworks engine exhausts to extinguish sparks; a float was installed in the first drill collar, and a kelly cock was installed in case of float failure. Drilling line string-up was changed from 6 to 8 lines because of the reduced buoyancy effect on the drill stem by air as compared with mud. Air lines and bleeder lines were equipped with gate type, steel, metal-to-metal seating valves. A burning pit was dug beyond the mud reserve pit, and a discharge line, a gas pilot line and casing bleeder line were laid to this pit. A check valve was placed on the discharge line to prevent fire from backing up the line to the well. A gas pilot burned continuously during air drilling and fishing operations. (See Fig. 6.)

A steel rotary hose was installed and used between 8756 and 9016 ft. Originally, it was thought that high air temperatures would require a steel hose since temperatures encountered prior to installing a water-fed cooling jacket on the air line were relatively high (Fig. 8). While drilling interval 9082-9150 ft, it was believed that the air was cooled sufficiently and conventional rubber rotary hose was used.

Mud kill lines and mud guns were rigged to the slush pump and a pit of water-base mud was maintained as a safety measure in case of fire. The blowout preventer closing unit was moved from the rig floor to a point about 100 ft from the rig.

Both diamond and hard formation rock bits were used to drill the section. Because of a lack of information on the Bristow No. 1, few comparisons were made.

One comparative section, however, was noted. In the 8825-8975 ft air-drilled interval in the Stull, 150 ft of hole was drilled with one hard formation rock bit in 18 rotating hours. This compared with a 128-ft interval in the Bristow from 8902 to 9030 ft, which was drilled with three similar bits in 49.5 rotating hours. The Stull averaged 8.3 ft per rotating hour; the Bristow averaged 2.6 ft per rotating hour using inverted mud in a 6¾-in. hole.

Circulating air volume on the Stull from 8756 to 9016 ft was approximately 950 cu ft per min at standard temperature and pressure, which would give an annular velocity of approximately 3500 ft per min in the 4¾-in. hole. Applied bit weight was 6000 lb. Rotary speed was 56 to 58 rpm.

The increased penetration rate of more than 200 percent using air is especially significant since a previous section indicated that penetration rates in the 4¾-in. hole and 6¾-in. hole were very nearly equal while drilling with water-in-oil emulsion mud.

Salt water was encountered at 8798 ft, and water intrusion continued while air-drilling for 214 ft. Gas produced with the water helped increase annular velocities to keep the hole free of water.

Penetration rates were as high as 20 ft per hour in some sections of the interval 8931-9016 ft. Circulating air pressures frequently reached 900 to 1000 psig although the normal was approximately 560 psig with air temperatures averaging 102 F.

Pipe was stuck while drilling at a depth of 9016 ft. Sixty barrels of oil were pumped into the hole and pipe was freed. The bit was pulled at this time. As the next bit was run, hole difficulties were encountered and attempts to continue drilling failed. A downhole fire occurred at this time — only 134 ft from the final total depth of 9150 ft.

Downhole Fire

In running the 86th bit into the hole, a bridge was encountered at 8944 ft. The kelly was picked up and air was circulated with normal air pressure of 575 psig at the rate of 950 cu ft per min while cleaning out from 8955 to 8974 ft. After rotating the kelly down to 8974 ft, air pressure increased to more than 800 psig and circulation was shut off. The rotary clutch was disengaged, and there was considerable back

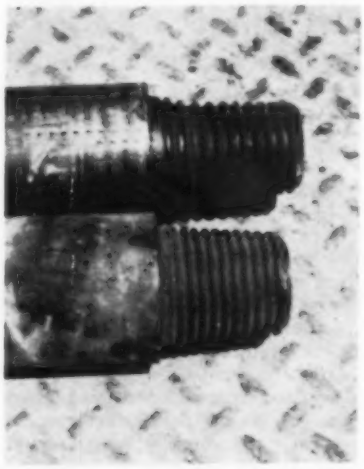

FIG. 9. **Heat from a downhole fire,** which resulted in the loss of bottom drill collar and eventual sidetracking of the hole, caused the second collar to stretch. The expanded collar (top) is compared with a normal 2⅜-in. IF pin (bottom).

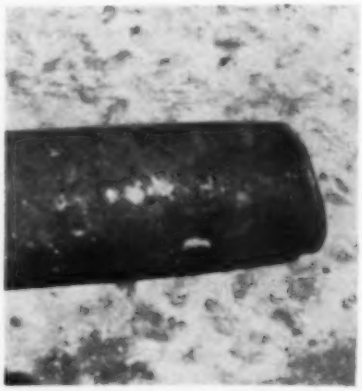

FIG. 10. **Lower section** of a piece of the bottom drill collar that was retrieved shows heat effects which caused it to part. Note necking down of the collar.

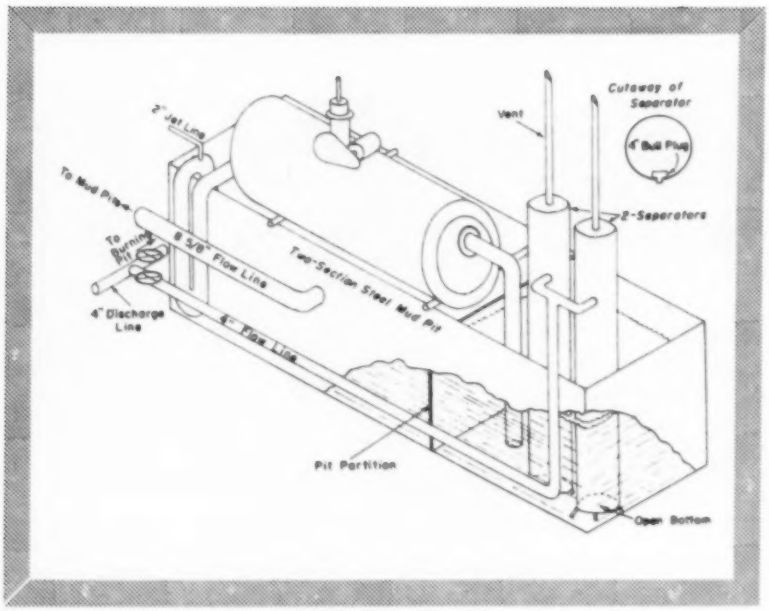

FIG. 11. **Air knockout equipment** used in the attempted aerated mud program. The two separators were shop fabricated.

torque in the drill stem. The pipe was picked up and found to be stuck.

Drill pipe was pulled to approximately 160,000 lb, or 60,000 lb in excess of weight of drill string. It jumped several times before it pulled loose. After freeing the pipe, the kelly bleed-off line was opened, and pressure inside the pipe failed to bleed off as gas continued to flow back through the pipe. The well was then killed with 130 bbl of inverted emulsion mud.

After killing the well, drill pipe was pulled, leaving the bottom drill collar, bit and float in the hole. Gas had flowed back through the drill pipe since the float valve was in the bottom collar. The pin on the second collar, which was screwed into the bottom collar, was elongated approximately ½-in. and appeared to have been pulled, rather than unscrewed, from the bottom collar. One unsuccessful trip was made in an attempt to screw into the first collar. Approximately 15 ft of the bottom collar was recovered on the next trip by screwing into its top joint. The piece of collar recovered was charred and necked down where the collar had parted. Pieces of drill collars recovered from the hole are shown in Fig. 9 and 10.

Since no surface indications of the fire were evident, exact time of its occurrence was not known. As a result, the exact cause could not be determined.

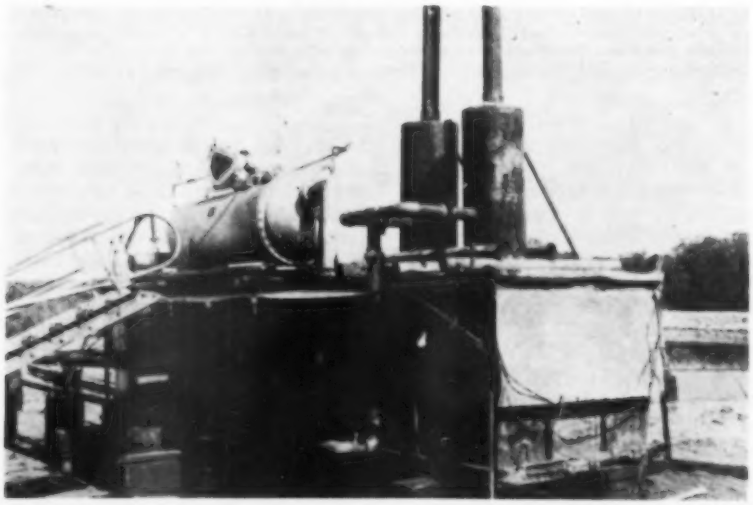

FIG. 12. **Air knockout equipment** consisted of a degasser, two separators, aerated mud flow line and flow line to mud pits.

Use of Aerated Mud

After recovering part of the fish, it was decided to attempt recovery of the remaining fish by using aerated mud. The first attempt was made May 31, 1956, after air knockout equipment and necessary lines were completed. The additional equipment was necessary since air and gas must be removed from mud before it can be pumped. Equipment consisted primarily of two shop-made separators manifolded as shown in Fig. 11 and 12, a degasser and a steel mud pit. A recording air meter was also installed on the injection air line (Fig. 14).

The hole was first filled with 8.3 lb per gal mud to a level at 2275 ft. On the first attempt, air was injected at three depths while going in the hole to 6800 ft. It was calculated that mud weights could range from a minimum of 3.1 lb per gal to 5.6 lb per gal, and it was first decided to use an air-to-mud ratio of 400 cu ft per bbl. This was later found to be too low to obtain required mud weight reductions. During the first attempt, air pressure as high as 1200 psig was used, using air volumes of 400 cu ft per min. Only partial circulation was regained.

A second attempt was made June 2. Pipe was run to 8600 ft, where partial circulation was regained; however, rod packing in the air booster unit failed. Air volume delivered by the compressors at this time was 800 cu ft per bbl with air-to-mud ratios of 400 cu ft per bbl.

On third attempt, circulation was established (June 3), by aerating the mud with an air-to-mud ratio of 800 cu ft per bbl. The system was circulating a mixture of 800 std cu ft of air per bbl of 8.3 bbl per gal of inverted emulsion mud. Mud circulation rates was 1 bbl per min. With equipment available, circulation could not be retained, however, since the slush pump was delivering the smallest volume of mud possible and large volumes of air probably would have increased surface pressures above the operating range of the booster unit. It is believed that mud aeration might have been accomplished had a booster unit been available with high output pressures, possibly in the range of 2000 psi. Further attempts were abandoned.

Fishing and Cementing

On June 5, mud was displaced with

air and top of fish found at 8937 ft. Several attempts to recover fish failed due to lost circulation, and it was then decided to remedy this situation before subsequent operations could be successfully resumed.

A lost circulation zone was cemented nine times with a total of 660 sacks of cement. Both fresh water and salt water were used.

After regaining circulation, several unsuccessful attempts were made to wash over the fish by using diamond washover shoes. It was then decided to set a whipstock and sidetrack the hole. An outside service was called to perform the operation, and no difficulty was encountered except for partial lost returns at 8981 ft.

Drilling continued to 9050 ft with water-base oil emulsion mud, where the system was again displaced with a water-in-oil emulsion mud.

Despite heavier bit weights and increased rotary rpm, penetration rates were reduced after changing the mud system to a water-in-oil emulsion.

Circulation was again lost in the Springer sand (topped at 9070 ft) at a depth of 9082 ft, and a 4-in. flush joint liner was set. Air drilling was continued to bottom.

The well was drilled to total depth with a hole diameter of 3¼-in., using 2⅜-in. drill pipe. Both diamond and rock bits were used. When the first rock bit was run, junk was found in the hole. On running a magnet, the hole was freed of junk — pieces of pellets which had not penetrated the liner when perforated for squeeze cementing to shut off water entering from the Springer formation.

Total depth of 9150 ft was then reached on July 31, 1956. Completion of the well had not yet been made at the time of this report, although tubing was run and Rig 36 was released on August 11.

FIG. 14. **Recording air meter** was placed on the air injection line to log air pressure continuously. In the background, left to right, are shown aerated mud air knockout equipment, blowout preventer closing unit, auxiliary light plant and reserve mud tanks.

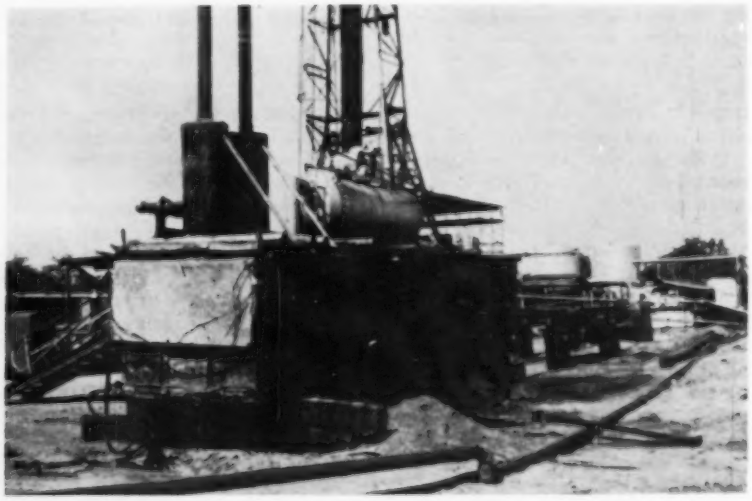

FIG. 15. **Aerated mud drilling** program made use of this air knockout equipment. The aerated mud system was used in several attempts to recover fish below 9000 ft. Circulation was established with a mud circulation rate of 1 bbl per min, an air-to-mud ratio of 800 cu ft per bbl and a circulating pressure of 900 psig. Use of aerated mud in the Mildred Stull met with little success.

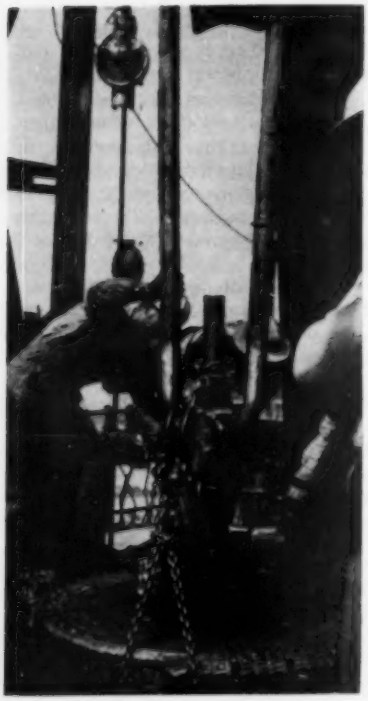

FIG. 13. **Pulling drill collars** from hole while air drilling necessitated special precautions. An air hoist line run through a pulley was used to hold this last stand of drill collars to prevent them from being blown from the hole by gas pressure.

Well Costs

Primary cause for high well costs on the Stull may be found as a result of lost circulation encountered below intermediate casing. Due to this lost circulation, drilling and completion time was extended and well service expenses increased. Had this lost circulation not been encountered, a savings would have resulted from the slim hole.

There were several savings to offset the increased costs caused by lost circulation problems. Of major importance was considerable savings on rig expense — despite extra reaming time. Further savings were realized on casing costs. The savings incurred do warrant a closer study and further deep tests using slim hole techniques and air and gas drilling. ★ ★ ★

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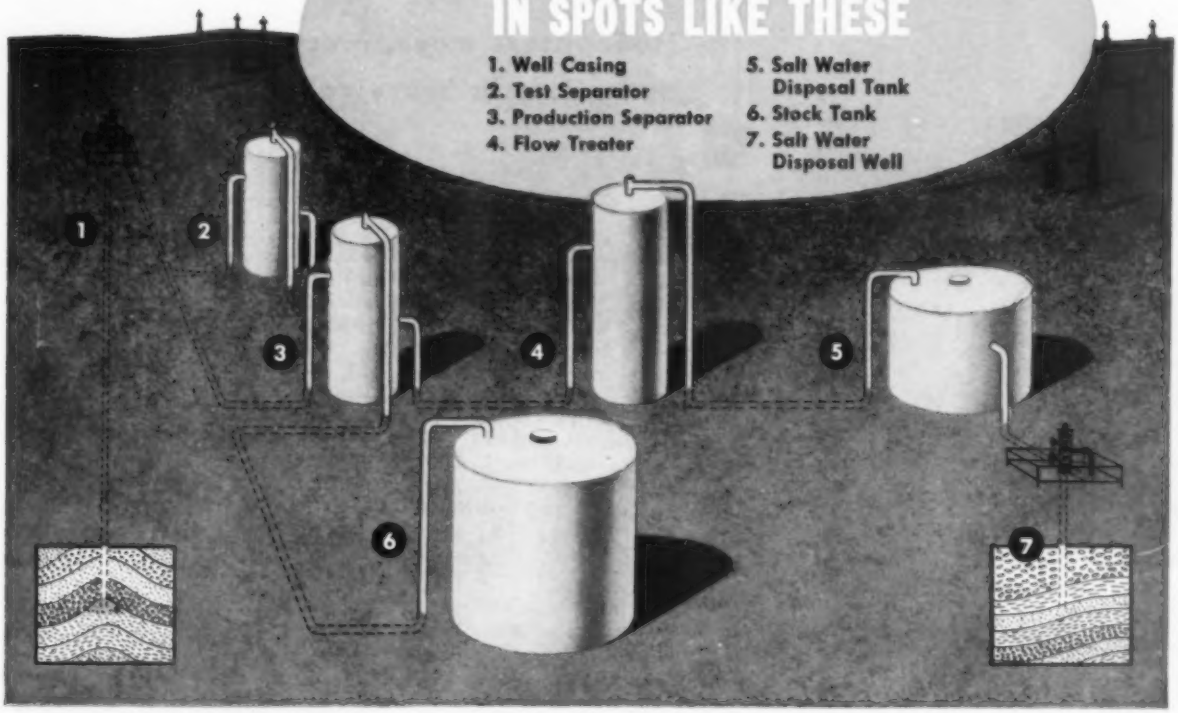

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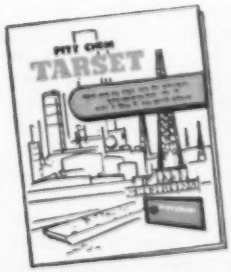

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Rig Lift in Papua

Helicopters move, erect and tend drilling operations in heavy rain and dense jungle

FIG. 1. **Tractor is flown into the rig site** area — in pieces. It is then reconstructed and the site is cleared and leveled. Helicopter weight limit is 4000 lb per load.

HELICOPTERS are speeding drilling operations in the jungles of Papua, on the east side of the island of New Guinea. Helicopters carried two 10,000 ft rigs to location, aided in assembling them, and have made it possible to sustain operations almost without interruption throughout the rainy season. Without the whirlybirds, drilling in the area might not have been possible.

The transportation problems solved are those of the Australasian Petroleum Company in its oil exploration on Papua, trusteeship of Australia, just north of the "Down Under" continent. Australasian's major shareholding partners are British Petroleum Company, Ltd. of London, Standard Vacuum Oil Company, and Oil Search Ltd. of Australia.

3000 Tons of Airborne Equipment

In seven months of operation, two rigs have been placed in operation on two separate locations; crews and equipment have been shuttled to rig sites, and drilling maintained by the helicopters. Since its beginning, there have been 1961 productive flights undertaken (as of August 4, 1957), carrying 6,385,128 lb of materials and equipment. Total flying time is 731 hours.

Australasian's two drilling sites are at Komewu and Sireru. The Komewu well is 8½ miles from the limit of navigation on the Aworra River and is still drilling at a depth below 4580 ft. The Sireru well is 13 miles from Victory Junction, at the fork of the Sirebi River and Sire Creek. This well was drilled to 1510 ft and was completed to its objective.

Helicopter Handling

Key to the success of these operations is in the cargo handling. Each helicopter load cannot weigh more than 4000 lb. Loads are assembled in slings or nets on the loading bay and are picked up by helicopters on a more or less continuous schedule, as weather permits. The helicopter does not land at the rig site but merely lands its load by a release hook.

Rigging-Up

Standard rigging up procedure demands that a bulldozer, stripped down to suitable loads, be taken to the proposed location first. After the tractor is reconstructed on the site, the area is cleared and a site is leveled for the drilling rig; then follows construction equipment for rig site buildings and living quarters for the crew; finally the rig and drilling tools and consumables for drilling. Because of the jungle terrain, it is necessary to confine the rig site to a small area. This increases the importance of the order of delivery in order that the site is not cluttered so that equipment cannot be landed exactly where required. The rig is flown into the site on a "lowest first" basis.

FIG. 2. **Portable tool shed** is the second item to be flown in to the rig location. This is followed by crew's quarters and last, rig components.

FIG. 3. **Helicopter base at Komewu,** with loading bays in the foreground. In the dismantling shed, in the background, rig parts are separated and readied for a trip to the rig location. Helicopters do not normally land at rig sites.

Most of the equipment is landed accurately in position directly from the helicopter: Skids onto foundations, tanks onto skids, or pump components onto skids. Even the substructure sections are spotted to within a few inches and can be easily and rapidly jacked into alignment.

Mast sections are set down on edge and supported in a vertical position with a timber stanchion before being released by the helicopter.

The drawworks, drive group and en-

gines are assembled at ground level some 100 ft from the substructure and, when complete, are skidded up a ramp into position. This allows the work of building the substructure and mast to proceed uninterrupted by the reassembly of the drawworks and drive group.

Despite weather conditions, loss and damage incurred in the helicopter operations has been negligible. So far, Australasian has lost only one fuel tank. Main risk to loss of equipment results from swaying of the load to the extent that the pilot finds it necessary to release it or it releases itself.

Thus far, drilling operations have been carried on — without time loss — through the worst season of the year. Low clouds are predominant in the delta area of Papua. Rainfall in the Sireru area for the two months prior to August 4 was approximately 95 in. — with 22 in. falling in the worst week. In the same two month period, there was a 16 in. rainfall recorded in Komewu.

Load Restrictions

Weight limitations on the helicopters required that nearly every item of drilling equipment be broken down into small loads. To illustrate, the American-made 131 ft jackknife mast and 10 ft high substructure on each rig was broken into 41 loads.

The drawworks, also made in the U. S. (as most of the equipment), made 11 loads. The drawworks was completely stripped down and brake-rims and high speed clutch removed from the drum shaft. The frame was modified by halving it vertically to meet the weight limit. Each of the four prime movers on each rig was separated into four loads. All engines are 300-hp diesels with torque converters. Two engines are used for the drive group and one for each independent pump. Three 7¼ by 12-in. slush pumps are used, two independent units and one compounded to the drawworks drive group. These were completely stripped to meet the weight limit. Power end frames were specially manufactured. Each pump makes 10 helicopter loads.

Rotary tables were specially machined and completely stripped. The 8-in. OD drill collars had to be shortened to 26.5 ft to meet the weight limit.

Both 4½ and 3½-in. drill tubing make up the drill stem. This, and the casing, was flown into the rig sites from the base camp to keep pace with rig requirements and loaded directly on the pipe rack.

For the two wells drilled, 13⅜, 9⅝ and 6⅝-in. casing has been used. For deeper wells on Australasian's drilling schedule, the company plans to run 18⅝, 13⅜, 9⅝ and 7-in. casing in strings of approximately 500, 3000, 5000 and 8000 ft, respectively.

FIG. 4. **After the rig erection is complete,** the helicopter continues as the most efficient means of supply and communication between the supply base and the rig.

As drilling continues, the helicopters continue to supply the needs: Drilling equipment, tubular goods or fuel. Here's the record:

TABLE 1. Helicopter Materials Handling at Komewu.

Days from start of helicopter operations to spudding-in date	33
Weight carried from start of helicopter operations to spudding-in date (lb)	1,025,947
Flights from start of helicopter operations to spudding-in date	283
Days drilling (to August 4)	116
Flights to maintain drilling (to August 4)	601
Weight carried to maintain drilling (to August 4) lb	2,175,697

TABLE 2. Helicopter Materials Handling at Komewu.

Days from beginning of helicopter operations to spudding-in	95
Weight carried from start of helicopter operations to spudding-in (lb)	2,039,977
Flights from start of helicopter operations to spudding-in	621
Days from beginning of fly-in of rig erection materials to spudding-in date	56
Weight of actual rig erection equipment carried was 594,023 lb, of which helicopter lifting gear constituted 2.9 percent	
Flights required to maintain drilling operations from spudding-in to completion of drilling	122
Weight carried to maintain drilling operations from spudding-in date of completion of drilling (lb)	314,422
Flying time from start of helicopter operations to completion of drilling (hr)	363

Drilling is being done with a minimum of downtime and no lost road building expense. Speed, safety, and dependability have been maintained. As an example, one helicopter flew 33 tons of material into the Komewu site in less than 11 hours flying time.

Acknowledgment

Photographs and information presented here are supplied through the courtesy of the Australasian Petroleum Company. ★ ★ ★

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For successful "first-time" cementing use the combination of BAKER CASING CENTRALIZERS to ensure ample clearance for placing a uniform body of cement around the casing—and BAKER WALL SCRATCHERS to scratch away the mud cake so that the cement will bond better with the exposed formation.

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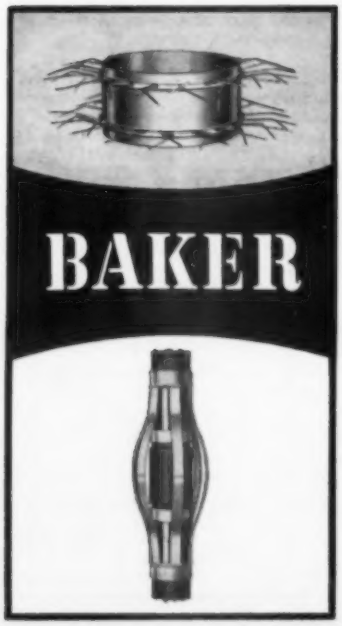

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Use of Air, Gas and Aerated Mud In...

Reduced Pressure Drilling

Penetration rates and bit footages have been remarkable. Here's some results, recent techniques, equipment used and method of application. There are some current limitations and some yet unsolved problems

Roy A. Bobo and George S. Boudreaux

Drilling Engineering Division,
Phillips Petroleum Company, Houston, Texas

FOR MANY years it was known that identical formations could be drilled on the surface much faster than in the earth, but the reason for this phenomenon remained obscured. The advent of gas drilling by the Western Natural Gas Company in Val Verde County, Texas, in 1952 brought about the realization that gas had some peculiar property that speeded up drilling rates and brought about longer bit life.

Many laboratory and field investigations have followed this first successful venture in drilling with natural gas. As a result, it is generally accepted that the improved bit performance which is obtained with air or gas may be attributed mainly to its low density. By virtue of this property, air or gas gives maximum relief of the vertical, axial stress that is inherent in the formation beneath the bit, and thereby increases the drillability of the rock.

Cunningham[1] conducting 1¼-in. micro-bit drilling tests on core specimens in a specially constructed pressure chamber obtained comparative drilling rates for various types of formations at different confining pressures. Murray substantiated the validity of Cunningham's laboratory work by showing a comparison with field drilling rates on the same formations. Micro-bit tests on seven different formation specimens of different hardness are shown in Fig. 1. These drilling tests, taken at constant rpm and weight show that the softer rocks such as shales are more responsive to a reduction in hydrostatic pressure. Fig. 2, representing micro-bit tests on Ellenberger dolomite, indicates that hard rocks may be drilled much faster at lower values of hydrostatic pressure at the higher bit loadings. All of the rock specimens used in the micro-bit tests were of low permeability.

Reduced pressure drilling may be defined as the drilling with a circulating medium whose effective return column (annular) density is less than that of muds which are in common use. At the present time it may be broken down into two categories — air or gas drilling and aerated mud drilling.

AIR AND GAS DRILLING

Before delving into the technique and requirements for drilling with air or gas, some of the results indicate savings that are possible over conventional drilling with mud. Fig. 3 shows a comparison of one mud and three air-drilled wells in the Vinegarone field of Val Verde County, Texas.

The Cauthorn A-1 was drilled with mud, and the B-1, C-1, and D-1 with air. Over 1000 rotating hours and 120 bits were saved per well by drilling with air in preference to mud. This does not include the time saved on trips. It is interesting to note the change in drilling rate on the graph where the B-1, C-1, and D-1 were mudded up. Since there was no change in formation, the graph vividly presents a comparison of air and mud drilling. Before mudding up the hole, penetration rates up to 90 ft per hour were achieved with air. This compares with rates of 3 to 5 ft per hour subsequently obtained with mud. Bit footages varied from 1000 to 1500 ft per bit for air as compared to 40 to 100 ft for mud.

The following comparison illustrates results which were obtained by Phillips in drilling with air on a well in the Puckett Ellenberger field of Pecos County, Texas:

Depth Interval	Type of Drlg. Fluid	Time-Rotating plus trip hr	Number of Bits
5000-9762′	Clear Water	825	53
5000-9762′	Air	285	10

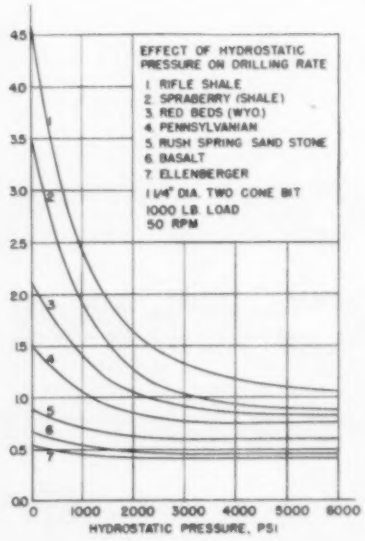


FIG. 1. **Response to reduced hydrostatic pressure** by seven formations to micro-bit tests made at constant bit load and rpm.

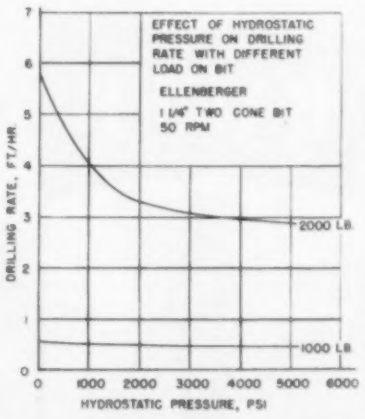


FIG. 2. **On Ellenburger dolomite,** micro-bit tests indicate that higher penetration rates are possible at lower hydrostatic pressures.

Presented at the Twelfth Annual Petroleum-Mechanical Engineering Conference sponsored by ASME held in Tulsa, Oklahoma, September 22-25, 1957.

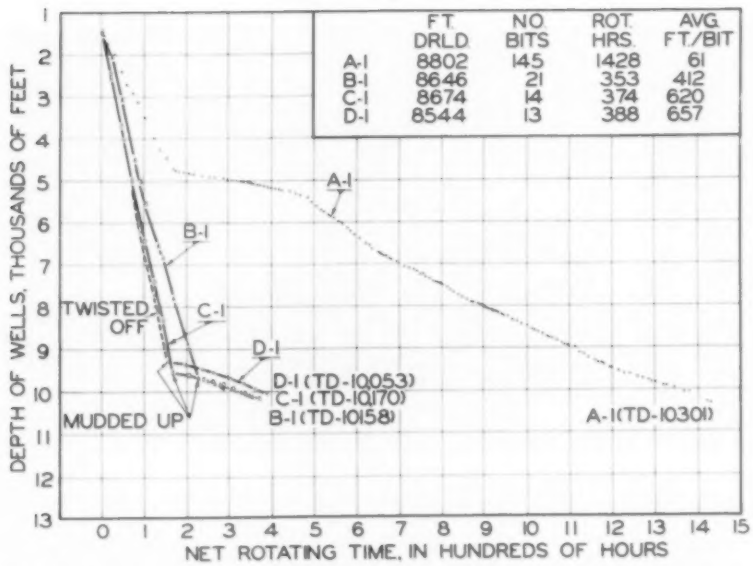


FIG. 3. **One mud-drilled, three air-drilled wells** in the Vinegarone field of Val Verde County, Texas, indicate savings possible in reduced pressure drilling compared to conventional mud drilling. Well A-1 drilled to total depth with mud.

Spectacular results have been obtained in other areas of the U. S. with air or gas drilling. For example, the following comparison of mud and air drilling has been presented for the Benzette Gas field, Elk County, Pennsylvania:

	Mud	Air
Ft drilled	5497'	5846'
No. of 8¾" bits	31	3 (2 tungstens)
Ft per bit	17.15	1907
Hr on bottom	320	172
Ft per hr penetration	17.5	33.2

Although many more examples could be quoted to show the large savings that can be made from air or gas drilling, many problems must be overcome before air or gas drilling can spread to other areas and take its place as a well developed science or drilling technique.

Volume and Pressure Requirements

The volume of air or gas required has been a major center of disagreement between companies that are drilling with air or gas. It has been reliably established from quarry drilling that an annular velocity of 3000 ft per min is satisfactory for surface conditions. Actually, the volume requirements are dependent not only upon the commonly accepted variables of depth, hole and pipe size, but on the rate of penetration as well. Analytical work due to be published[2] will show that errors in volume as great as 50 percent may be made by neglecting penetration rate at the deeper depths.

Pressure requirements also are dependent upon depth, drilling rate, hole and pipe size, and whether the formation is wet or dry. In dry formations, the normal standpipe pressure will range from 100 to a maximum of 200 psig. Moisture will increase this pressure to some extent, depending upon the amount of water entering the hole. For unloading of the hole after setting of surface or intermediate casing, higher pressures and the use of the aeration technique (simultaneous introduction of air and liquid) may be highly advantageous in saving of time.

Equipment Requirements

For all practical purposes, the arrangement of the rig equipment is the same as for conventional mud drilling with the air or gas supply line being tied directly to the standpipe. A typical schematic diagram of an air drilling hook-up is shown in Fig. 4. Note that features which are additional to conventional drilling are the compressors, rotating head, flow line, gas detector, and centrifugal blower.

This equipment includes two innovations to air drilling rigs — the gas detector, and the centrifugal fan. Both are deemed important safety contributions to air drilling.

Gas detector. A commercial gas detector may be installed off a tap in the flow line to detect whether gas is being produced from the well and to determine the relative amount. It may be connected to sound an alarm when excessive quantities are encountered.

The gas detector also may be used with the rig's depth-drilling rate indicator to serve as an exploratory device. Fig. 5 shows a commercial model gas detector rigged up on a well in West Texas.

Centrifugal blower. One of the prime hazards when drilling with air or gas is the apparently inevitable leak around the rotating and wellhead assemblies. This danger can be entirely eliminated by holding a vacuum on the discharge line and wellhead.

A fan assembly having a 33-in. blast wheel driven at 1100 rpm handled the solids from 10,000 ft of air-drilled hole in two Phillips' wells. This unit is shown in Fig. 6. Although the useful life of the fan was terminated when the case became eroded, the cost for its use was considered quite low.

Effective use of a blower will necessitate a fairly large flow line in order to minimize loss of head. Since it is necessary to design the discharge system to handle some formation gas, a conveying velocity of 5000 ft per min is suggested for systems designed to handle about twice the normal quantity of drilling air or gas. If cuttings settle out in the discharge line when no formation gas is being drilled, a wellhead arrangement such as Fig. 7 can be used to admit air at atmospheric pressure, and thus maintain an adequate conveying velocity in the discharge line.

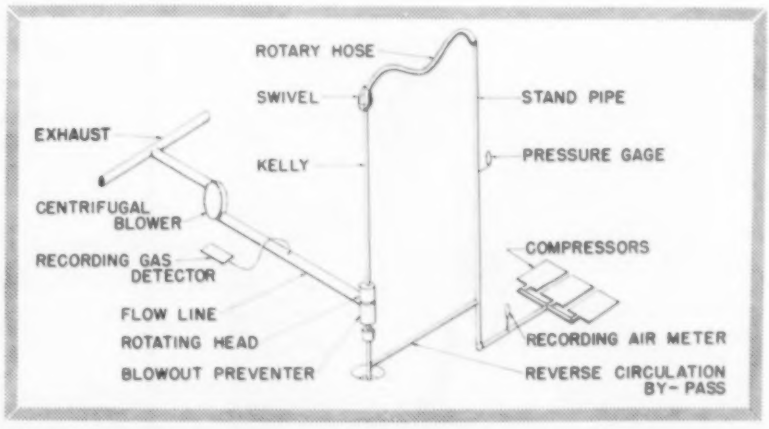


FIG. 4. **Typical hookup for air-gas drilling** is similar to conventional drilling arrangements with the addition of compressors, rotating head, flowlines, gas detector and centrifugal blower.

A provision to by-pass the fan is desirable if water is encountered.

In order to eliminate any hazard when handling an explosive mixture an electrician should check the electrical ground existing between the fan housing and the discharge line, motor drive and exhaust line from the fan. A check should also be made for grounding the fan rotor and a discharge brush provided if required. Static conducting belts should be used if a belt drive is employed. A hydraulic drive will allow location of the prime mover away from the fan and should be used for maximum safety if the prime mover is a source for ignition.

The nomograph presented in Fig. 8 has been prepared to determine the required pipe size for different conveying velocities and to ascertain the total fan head required for air handling. This total fan head includes the friction drop in the line, the entrance loss, and the velocity head based on a fan system which is drawing atmospheric air from an open ended suction line. Technically, the design procedure would require a density correction for natural gas but this correction can usually be omitted without serious error. A correction factor for solids loading can be obtained from the nomograph presented in Fig. 9. The design steps are:

1. Select a design air rate. This is the normal drilling air or gas plus the formation gas that can be expected. It is suggested that the design air rate should be at least double the normal air or gas circulation rate.
2. From the nomograph in Fig. 8, select a line size that will give a linear velocity of 5000 ft per min at the design rate. Also determine from the nomograph the fan head required for handling air at the design rate.

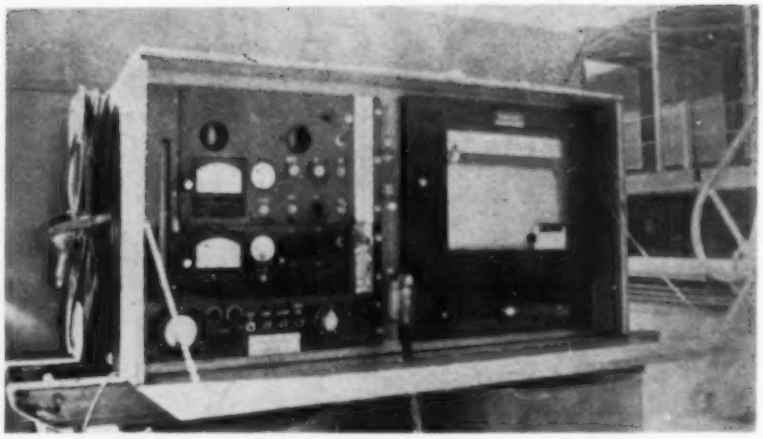


FIG. 5. **Commercial model gas detector** installed on West Texas well (on return flow line) to determine relative amounts of gas produced. Device can sound an alarm and can be tied in with depth-drilling rate indicator.

3. From Fig. 9, find a solids correction factor based on the design air rate, the expected maximum drilling rate and the hole size.
4. Multiply the fan head obtained in Step 2 by the correction factor obtained in Step 3 to obtain the corrected total fan head for air laden with drilled solids.
5. From fan characteristic curves such as Fig. 10, determine the required rpm and fan drive horsepower.
6. Select a prime mover to supply 1.5 times the indicated horsepower to the fan drive. A hydraulic drive powered by an internal combustion engine is recommended.

Example 1:

Normal Drilling Air — 1500 cfm
Design Air Rate — 3000 cfm
Length of Discharge Line — 200 ft
Maximum Expected Drilling Rate— 60 ft/hr
Hole Size — 8 in.

From Fig. 6:

Line Size for 5000 fpm = 10½ in. ID
Fan Head Required for Air Handling = 9.5 in. of water.

From Fig. 7:

Solids Correction Factor = 1.27
Corrected Total Fan Head = 1.27 × 9.5 = 12 in. of water.

From Fig. 8:

Use 1565 rpm for 12 in. Head and 3000 cfm
Drive Horsepower = 10
Use 1.5 × 10 = 15 Drive Hp.

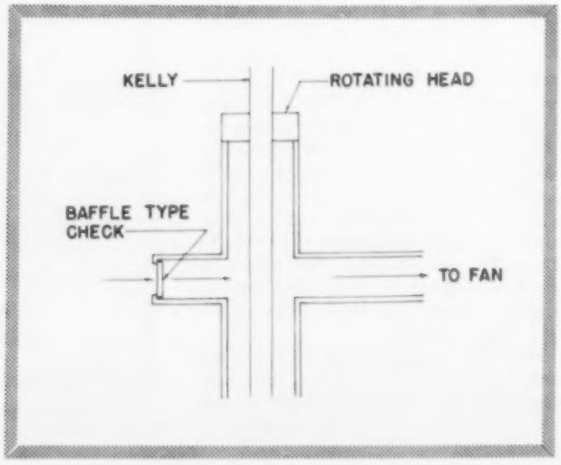
For hydraulic drive (80 percent overall efficiency), engine horsepower rating for continuous service = 15/.8 = 19 hp.

Technique

The technique of air or gas drilling is similar to mud drilling with the exception that one circulating fluid is a

FIG. 6. **Paddle wheel blower** holds slight vacuum around rotative and wellhead assemblies to eliminate gas leaks that might form fire hazard.

FIG. 7. **Wellhead arrangement** to admit atmospheric air for maintenance of conveying velocity when no formation gas is produced.



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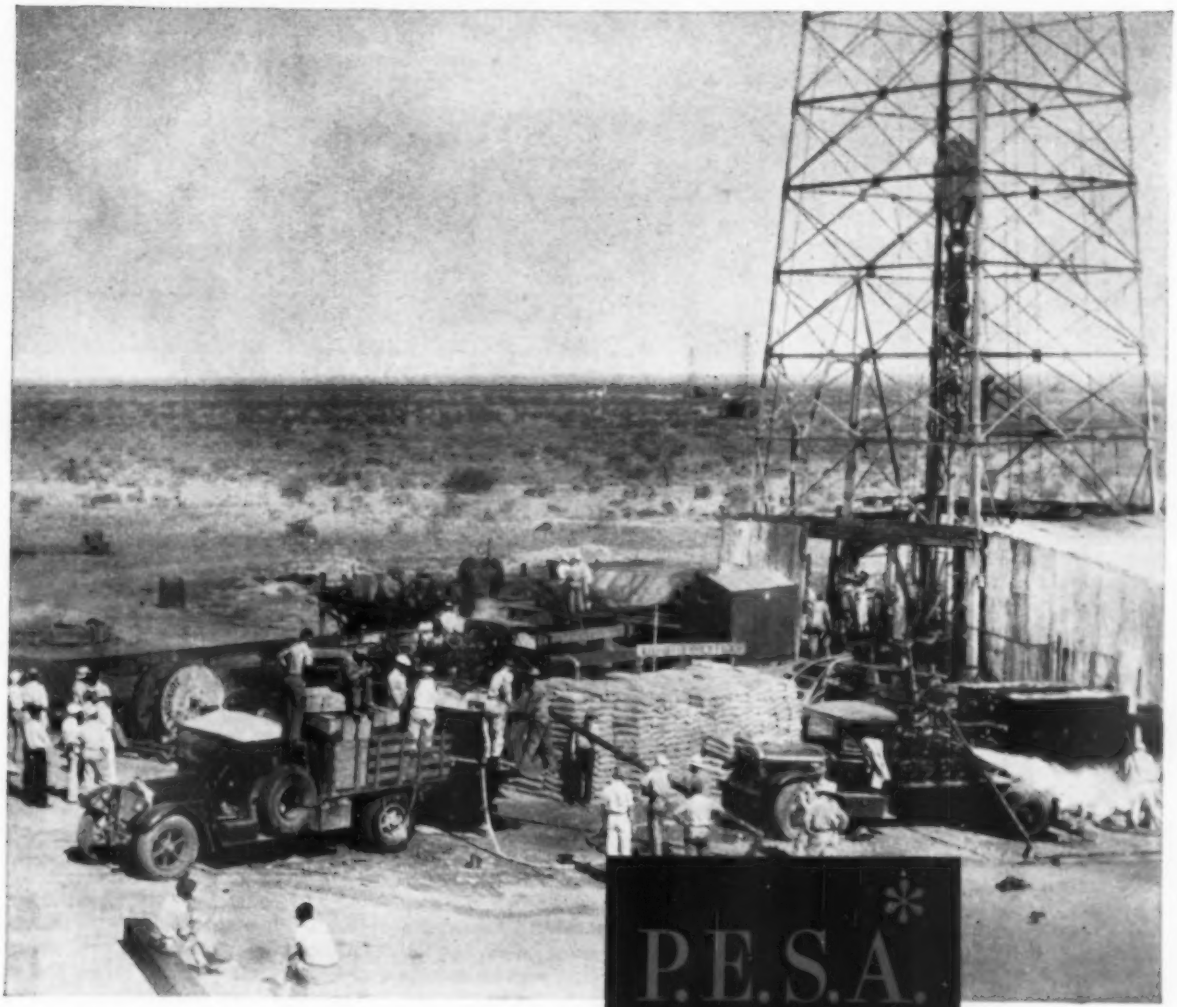

The McElroy Number 103 of Upton County, Texas was started in 1933 and completed in 1935 by a major oil company. It set new records for cost, time to complete, and weight of casing string.

This test was the deepest, (12,786 feet), the most expensive (over $1,000,000) and had the heaviest string of casing (10,301 feet of 7⅝") ever used. It took longer to drill, (over two years) and used more bits (965) than any other well. *Moreover, no important producing formations were discovered.*

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compressible medium and the other is not. As has been shown, penetration rates are much faster when drilling with air or gas. In many cases, bit weights are much lower, either because they are not necessary for exceptional penetration rates, or because hole deviation becomes a problem at the high drilling rates.

Problems in Air Drilling

Up to this point, only the favorable results have been shown in drilling with air or gas. But what about the problems?

In areas where formations are dry, no serious problems exist with the possible exception of hole deviation and pipe stresses. Unfortunately, not too many areas have long sections of hole that are completely dry. Water intrusion is the greatest single deterring factor to air or gas drilling.

Water. Water intrusion can be broken down into two types — weeping water zones and prolific water zones. Weeping formations can usually be penetrated if enough care is taken. However, they do slow up penetration rates and present the danger of sticking the pipe in the hole due to the cuttings balling up from the moisture and sticking to the drill string. Several methods are being used to penetrate these weeping zones successfully. Additional water added periodically at the surface has helped to overcome the stickiness and allowed drilling ahead. Aeration drilling by Phillips demonstrated that foaming would reduce the surging that results from lifting of fluids from the annulus, and give improved lift efficiency. Murray[3] reports on adding foaming agents to the air stream to help in lifting water from the bore hole.

However, the biggest problem is the prolific water zones that give up large quantities of water. These zones must be sealed off for three reasons:

1. The influx of water increases the hydrostatic pressure on the rock thereby slowing penetration rates;
2. Disposal of the water on the surface is too great a problem to overcome when producing large quantities of water, and
3. The air and water may create a corrosion problem as will be pointed out in the aerated mud section.

To successfully air drill, these zones will have to be sealed off against high pressure differentials. For example, at 10,000 ft with a normal pressure gradient of water, it can be anticipated that approximately 4000 psi will be the formation pressure tending to flow water into the hole. Since there is practically no hydrostatic pressure when drilling with air, any sealing material in this case will have to withstand 4000 psi of pressure differential. For this reason, there must be penetration of the sealing material into the formation to form a strong bond that will withstand these high pressures. It is known that water may be present in large quantities in such zones as sands, fractured limestones, vugular limestones, and dolomites. Since solids will plaster off on the face of a sand and not penetrate it, the problem is resolved into finding a liquid with a very low viscosity that would penetrate the formation and then ploymerize or gel.

Several materials have been found that show a great deal of promise but have yet to be proved convincingly in field practice. The successful solution to sealing off water zones will open more areas to air or gas drilling and will pave the way to greater savings for the oil industry.

Water location. Many wells have been drilled with mud in areas that need to be investigated for possible air drilling. However, electric logs can only indicate where water might be present and whether it could be of sufficient quantity to hinder air or gas drilling. Naturally in the past, operators have been looking for oil and/or gas and no one has paid too much attention to locating water. The logging companies are now aware of the problem and are investigating it. Two questions need to be answered: (1) Are the formations dry for air or gas drilling? (2) If the problem of sealing water zones is solved, how many formations will have to be sealed off during air or gas drilling?

Pipe stress. With any method of rock bit drilling, several torsional and vibratory or shock stresses are transmitted to the pipe. These stresses tend to be dampened out to some extent by mud in the hole. With air, no dampening occurs and no mud is in the hole for buoyancy of the pipe during trips. For these reasons, the drill string during air drilling remains in a higher state of stress than is prevalent with mud. The additional damage to the drill pipe will be determined only after more experience is acquired at greater depths with air drilling. There are some indications

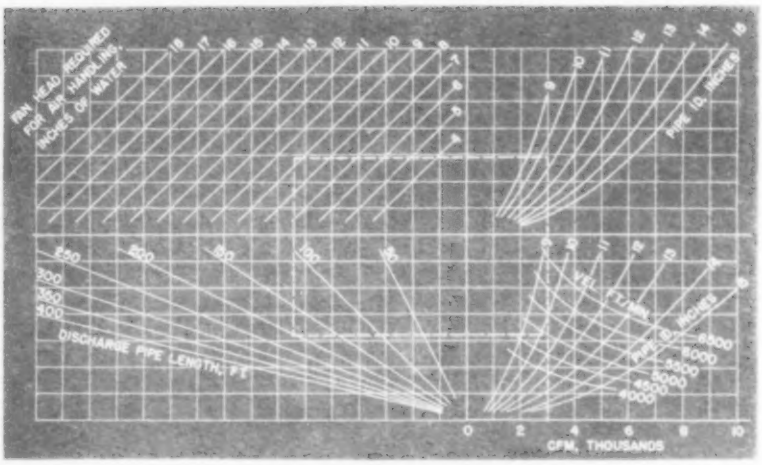

FIG. 8. **Flowline size and total head required** for air handling can be determined from this nomograph.

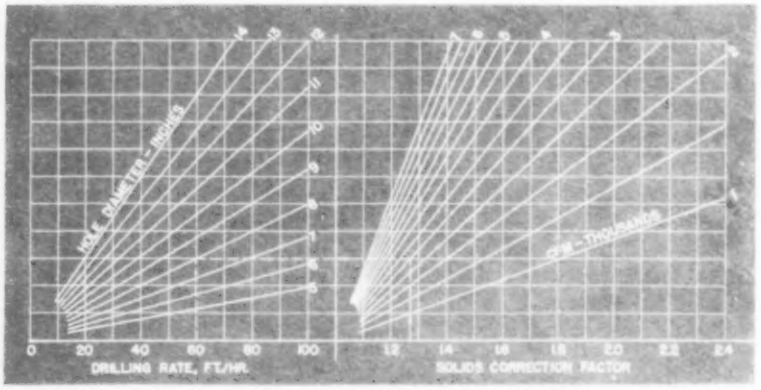

FIG. 9. **Correction factor** for solids loading can be obtained from this nomograph, which when multiplied by the fan head required for handling air at the design rate, gives the correct fan head for air laden with drilled solids.

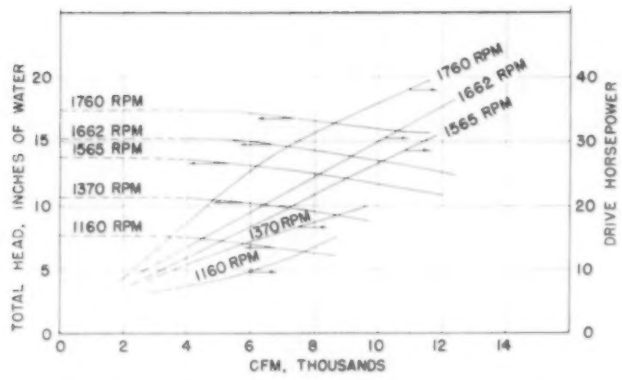

FIG. 10. **From centrifugal blower characteristics,** such as that shown above, fan horsepower and fan speed can be determined for air or gas drilling.

FIG. 11. **Steel rib type stabilizer** used immediately above the bit has an OD 1/8-in. less than bit OD. Conventional rubber stabilizer placed about 60 ft above the one shown to maintain straight hole in air or gas drilling.

that the damage will not be sufficient to enter into the economics of air drilling. However, it should be kept in mind until conclusive evidence is found to show whether this will be a problem or not.

Hole deviation. In the initial field trials of air and gas drilling, hole deviation was a serious problem which necessitated carrying much lower bit weights than desired. Holes were drilled as much as 40° off vertical.

Realizing the fact that most holes drilled with air or gas are usually in gage and that stabilization of the drill collars would probably be effective, hole deviation was maintained close to vertical in the wells drilled in the Vinegarone field, Val Verde County, Texas, by use of a steel-rib type stabilizer immediately above the bit and a conventional rubber stabilizer approximately 60 ft above that. The steel ribbed stabilizer is an old tool, which has been little used in recent years. Results were better than anticipated since the Vinegarone field is in an exceptionally bad crooked hole area.

Fig. 11 shows the tool which consists of a 20 ft section of 7-in. OD drill collar with ribs welded to its outside to bring the collar diameter to ⅛ in. smaller than the bit being used. These ribs are installed, starting immediately above the box in two 8½ in. segments, with the ribs indexed or staggered so that those of the upper segments are aligned with the circulation grooves in the lower segments.

Future of Air and Gas Drilling

The future of air and gas drilling is assured. The savings in time and money are almost unbelievable and have been proved in certain areas of West Texas, New Mexico, Arizona, Oklahoma, Rocky Mountains, and Canada. The successful solutions to locating water and sealing off water zones will open up many more areas to drilling with air or gas and will lead to greater savings for all who take full advantage of this new method of drilling.

AERATED MUD DRILLING

Shortly after the Western Natural Gas Company's successful air drilling venture in Val Verde County, Phillips Petroleum Company initiated an investigation into aeration, or aerated mud drilling. Aeration involves the simultaneous introduction of air and mud into the standpipe for the primary purpose of reducing the density of the return mud column.

Purpose of Aeration

The initial work with aerated mud had as its primary purpose remedy of loss of circulation. Later, investigation was made to utilize aeration as a means of increasing penetration rates and bit footage, with the primary objective of overcoming some of the disadvantages of air drilling. For example, no positive way had been devised in air drilling to accomplish these purposes:

1. Penetrate weeping shales or low-volume water zones.
2. Prevent rapid and possible disastrous disintegration of exposed shale zones when water is encountered.
3. Seal off water zones which are encountered without subjecting a dry-walled hole to water.

In aeration drilling, low volume or weeping water zones present no problem. Possibilities also exist of employing liquids which protect and/or prepare shales against hydrous disintegra-

FIG. 12. **Sample drilling chart** from Phillips Evelyn Jo No. 2 in the Puckett field of Pecos County, Texas, shows graphically the rapid increase in drilling rates by aerated mud drilling.

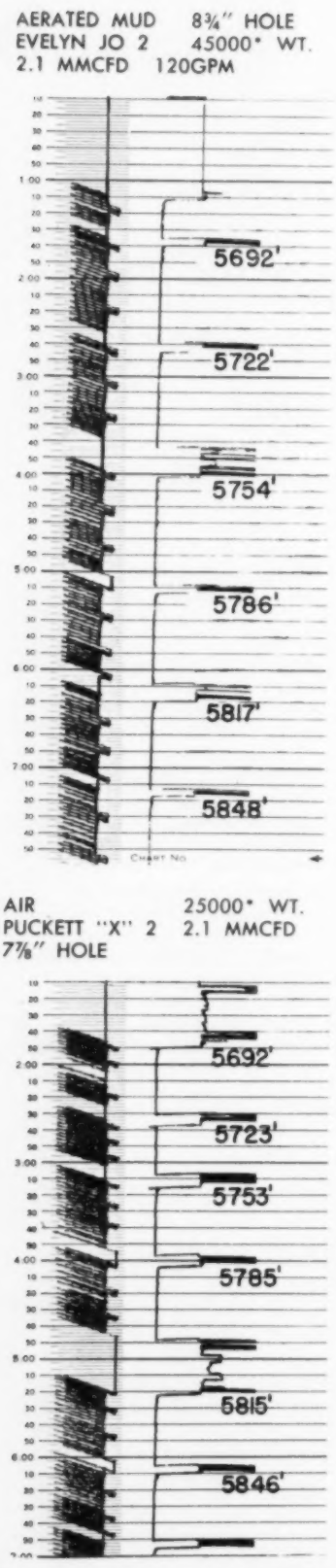

FIG. 13. **Aeration and air drilling** are compared for the same section in two Puckett-Ellenberger field wells.

tion. Further, aeration will always be safer, conversion from aeration to liquid for purpose of killing a well requiring a matter of minutes. Aeration also possesses other advantages regarding sealing of water zones in that conversion to liquid may be resorted to for purpose of penetrating large volume water bearing formations.

Field Results

Substantially greater bit footages and penetration rates were obtained by aeration drilling on each of four wells in the Puckett-Ellenberger field, Pecos County, Texas, than on offset wells which were drilled with clear water. On the otherhand, the results which subsequently were obtained with air drilling in the same field showed about the same advantage over aeration, as was obtained by aeration in contrast to clear water. These contrasts were obtained in the drilling of shales, sandstones, and sandy shale formations, all of which are highly responsive to reduced pressure drilling.

Graphic evidence of the rapid increase in drilling rates which results from aeration drilling may be seen from the drilling records of Fig. 12. In this illustration, examples have been picked at random to compare penetration rates during aeration to those which were obtained either prior to or after introduction of air.

Comparing the Phillips Evelyn Jo No. 2 to the Phillips Evelyn Jo No. 1, a clear water-drilled hole, a savings of 26 bits was made in the interval from 5600 to 8523 ft.

A comparison between aeration and air for the same section in two wells drilled in the Puckett-Ellenberger field is shown in Fig. 13. Note that 185 ft of hole was drilled with air at a rate of 46.8 ft per hr with an applied bit load of 3180 lb per in. of bit diameter. This contrasts with a like footage drilled by aeration at an average rate of 29.6 ft per hr, with bit loading of 5140 lb per in. of diameter.

Volumes and Air-Liquid Ratios

Since bottom-hole drilling pressures exercise so much control over the penetration rates and bit footages, it is highly important in aeration drilling to maintain the highest possible air-mud or air-liquid ratios. This means drilling with the lowest mud rates that will still safely remove the drilled cuttings from the hole.

At low air-liquid ratios, the circulation rate of the mud pump is the limiting factor in regard to annular removal of bit cuttings. In hard formations where clear water is used, an annular velocity of 100 ft per min is adequate for cutting removal. The annular velocity will be achieved with a pumping rate of 175 gal per min in a conventionally drilled 7⅞-in. hole having 4½-in. drill pipe. In two of the first wells drilled by aeration with 750 Mcfd below 9000 ft, adequate cutting removal velocities resulted at circulating rates with clear, lime water of 150 gal per min. On a subsequent well, where 2

The Authors

Roy A. Bobo is director of Phillips Petroleum Company's Drilling Engineering Division at Houston, Texas. He was graduated from the University of Oklahoma in 1936 with a BS degree in electrical engineering and joined Phillips that year. During his 21 continuous years with Phillips, he has been associated with practically all phases of drilling and production operations. In 1944 he was made assistant regional superintendent at Houston, and when the Drilling Engineering Division was created in 1952, he was made director of that division. Author of many drilling papers, Bobo has been responsible for many advancements in air, gas and aerated drilling techniques. A member of AIME and API (1957 chairman of Houston Chapter), he is also a member of the Engineering Committee of the AAODC.

George S. Boudreaux is a research drilling engineer in Phillips' Drilling Engineering Division at Houston. Upon graduation in 1949 from Louisiana State University with a BS degree in mechanical engineering, he became affiliated with Phillips. He has held successive jobs as staff engineer and district engineer prior to his present assignment in 1955. Boudreaux has authored and co-authored several papers on aerated drilling methods, and is co-author along with Bobo of a soon-to-be-published handbook pertaining to the engineering fundamentals of the drilling process. He is a member of AIME, API, the Joint API-AAODC Committee on Air and Gas Drilling and the AAODC Rotary Drilling Committee. He aided in pioneering air, gas and aerated mud drilling and has done research on water shut-off problems.

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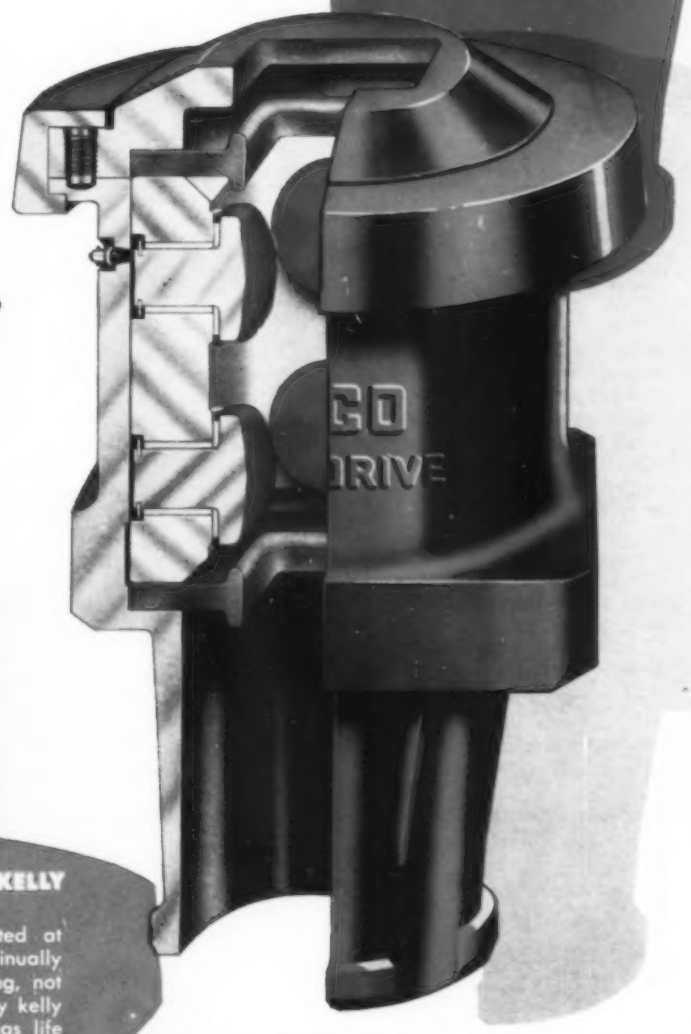

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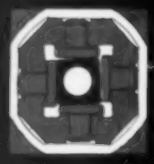
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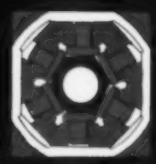
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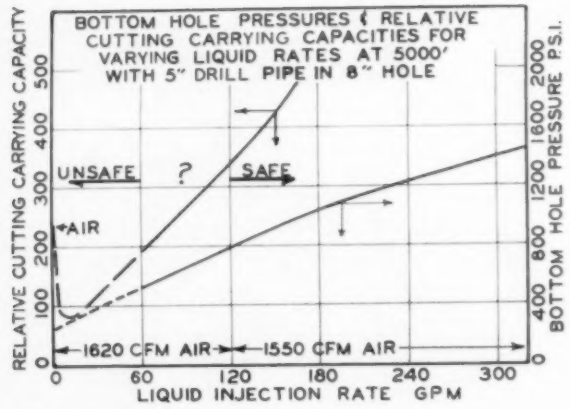
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RELATIVE CUTTING CARRYING CAPACITY
BOTTOM HOLE PRESSURE P.S.I.
UNSAFE
?
SAFE
AIR
1620 CFM AIR
1550 CFM AIR
LIQUID INJECTION RATE GPM

FIG. 14. **Bit cutting removal capacities** for various liquid injection rates and bottom-hole pressures. Pressure recorder placed at end of 4980 ft of 5-in. drill pipe inside 8⅝-in. casing.

MMcfd of air was used in an 8¾-in. hole and 5-in. drill pipe, cuttings were removed at liquid rates as low as 120 gal per min to a depth of 6000 ft.

All of the liquid rates mentioned with their respective air volumes in the preceding paragraph were adjudged by field conditions to be the minimum that would be permissible for the respective pipe and hole sizes. Further, the rates would be satisfactory for holes that remain fairly true to gage with no shale sloughing.

BHP and Cutting Removal

In order to determine the bottom-hole pressures which result from the various air mud ratios during aeration drilling, and to evaluate the most valid theoretical equations pertaining to aeration, bottom-hole pressure tests were made with the use of a special recording instrument. The recorder was run on the end of 5-in. drill pipe to a depth of 4980 ft inside 8⅝-in. casing, where it remained throughout the tests. Pipe was rotated to simulate drilling conditions. To obtain varying air mud ratios, the mud pump rates were varied from 300 down to 60 gal per min while the compressor air rate was maintained at a relatively constant rate (1550 to 1630 cu ft per min), except for the initial unloading phase, where half compressor capacity was employed.

A summation of the bottom-hole pressures resulting from the various test conditions is shown in Fig. 14. From the pressure information, it was possible to calculate the relative cutting carrying capacities (lifting force per pound of bit cutting) for the various mud and air rates. Observe the rapid decline in cutting carrying capacity as the liquid injection rate is reduced below 120 gal per min. Also at these lower liquid rates, note the increasing standpipe pressure associated with decreasing bottom-hole pressures.

These adverse changes in cutting carrying and the increasing standpipe pressures at liquid rates below 120 gal per min indicate a rapidly changing flow condition both inside and outside the drill string. Literature indicates that at the low liquid injection rates and high air rates that a greater percentage of the liquid phase tends to flow as a liquid film along the walls of the pipe. This accelerated reduction in liquid associated with the aerated flow stream increases the slippage of the liquid in air. For this reason, and the fact that the liquid phase is the cutting carrying medium, reduced liquid injection rates will result in an accelerated reduction in aerated mud cutting carrying capacity.

At extremely low liquid injection rates, most of the liquid phase is thrown toward the wall of the pipe (and bore hole) as a result of turbulence. The adhesive force between the pipe and the liquid is sufficiently high to form and maintain a liquid film. The small amount of liquid in the air stream will form small disconnected droplets which will slip at a much higher velocity than

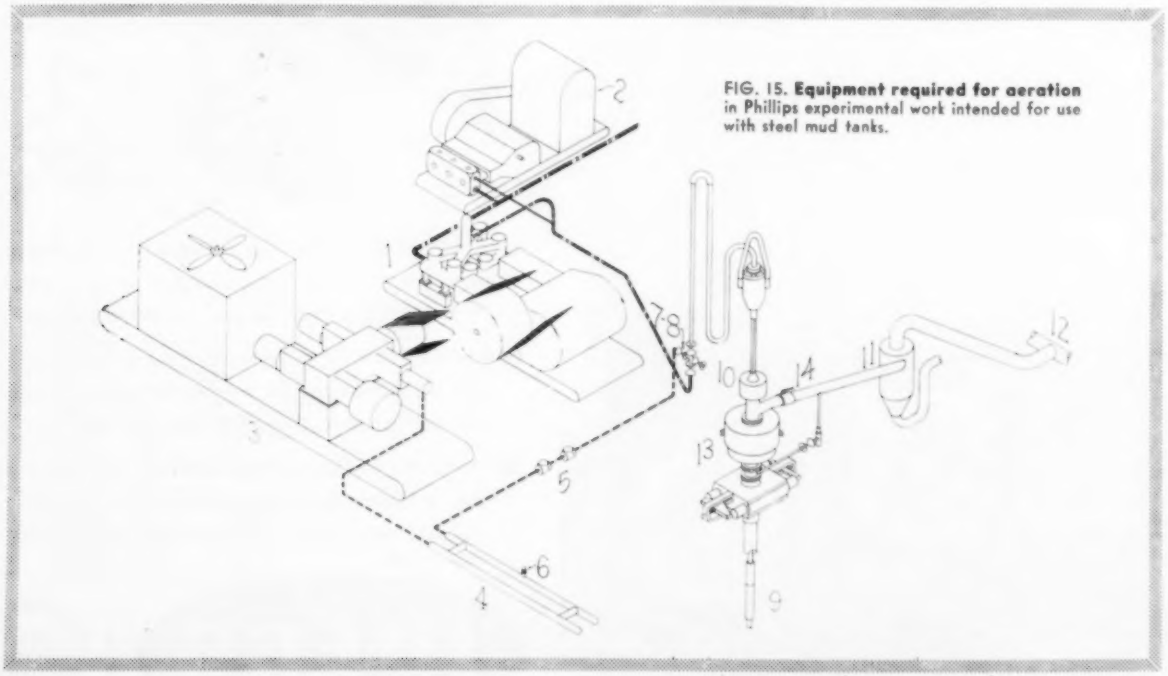

FIG. 15. **Equipment required for aeration** in Phillips experimental work intended for use with steel mud tanks.

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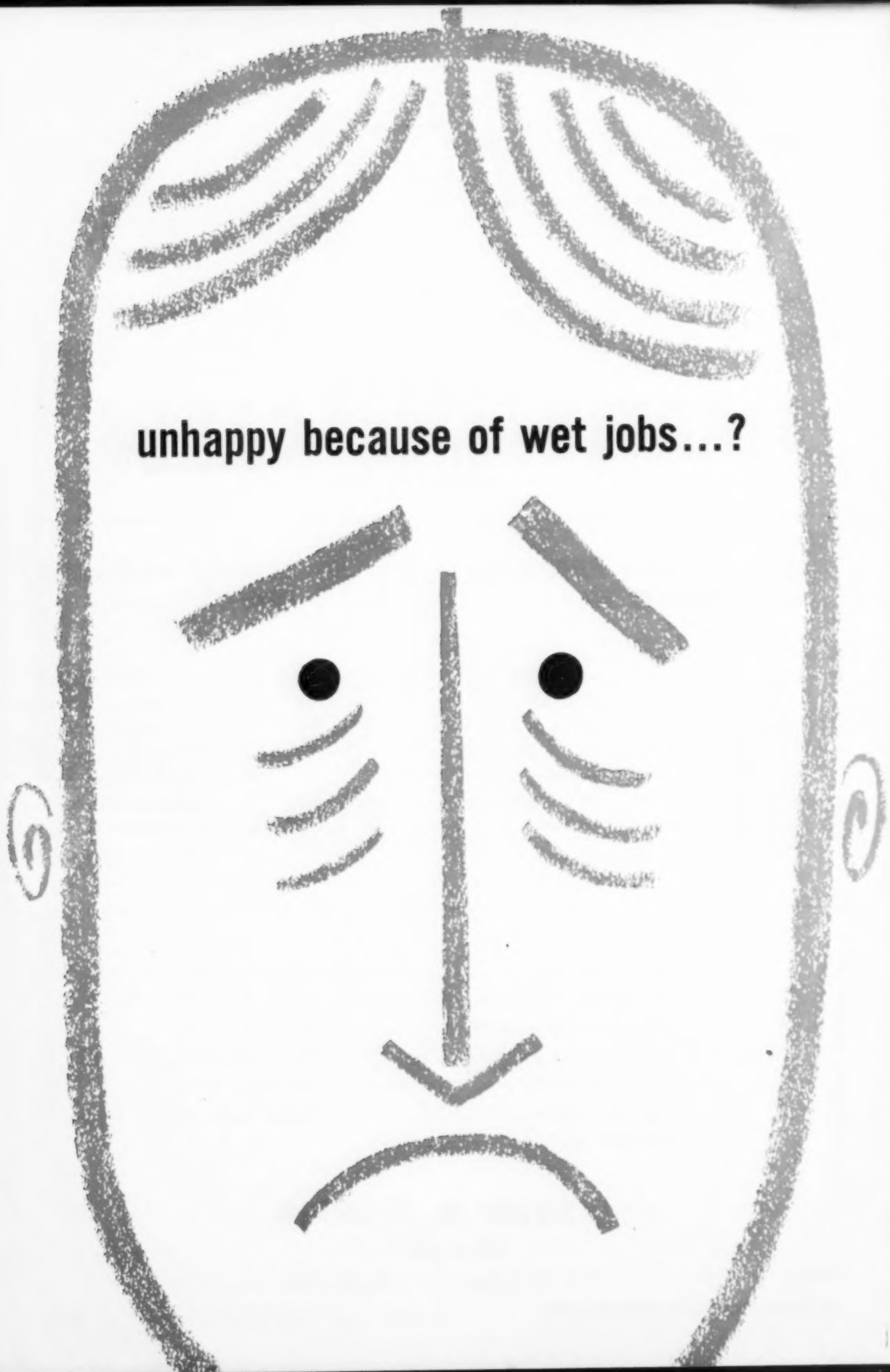
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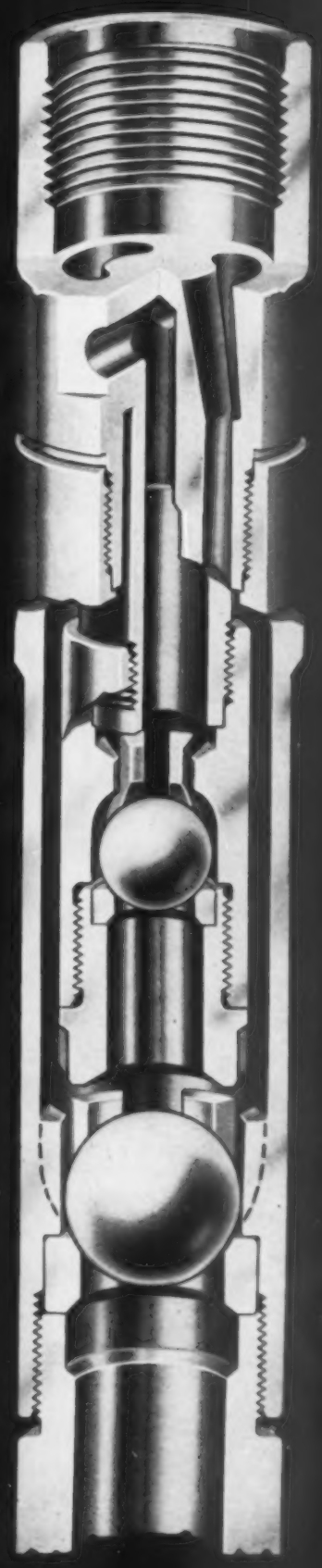

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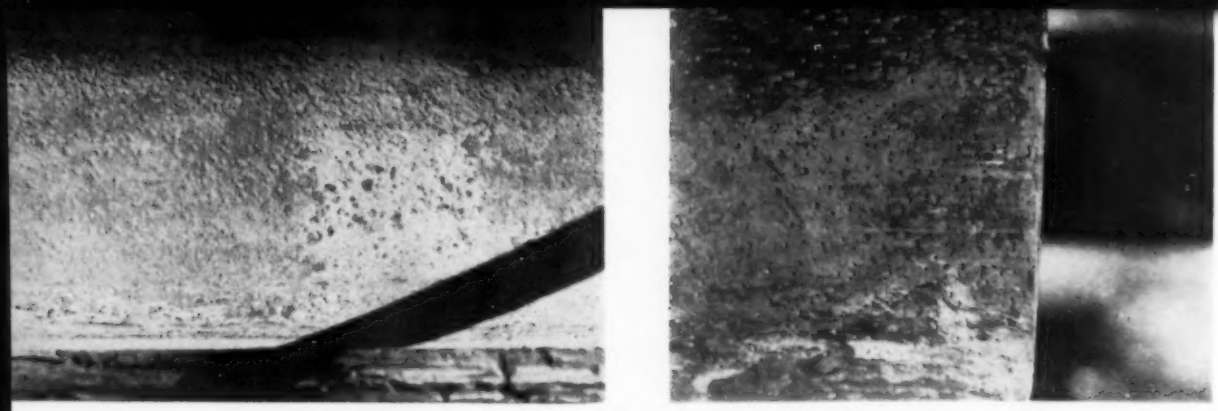

FIG. 16. **Corrosion damage** to drill string in aerated drilling.

the liquid phase in an aerated system having a high liquid injection rate.

At the high liquid rates, the relative slip rate between the two phases is much lower because the liquid phase becomes the continuous phase and the air phase becomes a disconnected phase forming bubbles.

For the conditions represented in Fig. 14, the mud injection rate could safely be reduced to 120 gal per min, but not below this value.

Fig. 14 also illustrates that the ability to convey cuttings from an air-drilled hole will drop markedly when even small volumes of water are added to the flow stream, or are picked up during the drilling procedure.

Equipment Required for Aeration

The equipment used for Phillips Petroleum Company's experimental work on aeration is shown in Fig. 15. The system as shown was intended for use with steel mud tanks. In field trial, circulation of the liquid phase through earthern reserve pits instead of the steel mud tanks make possible extension of the flow line to the far end of the reserve pit, thus eliminating the necessity of the separator. The butterfly valve (14) was removed from the flow line.

Other systems using independently driven compressors and retaining the mud pumps normally on the rig may be employed. The primary requirement is that the compressor have ample pressure and volume for the job, and that the rig pump be able to establish minimum pumping rates should high air-liquid ratios be desired.

Problems — Aerated Mud Drilling

Corrosion. The earliest problem to arise in connection with aeration drilling was that of corrosion to the drill string. The corrosion most generally experienced is of the oxygen cell type, which can be extremely severe, and cause extensive damage to a string of drill pipe during one bit run. For some unexplained reason, the major portion of such damage is external to the drill string (Fig. 16). where sulfide bearing waters are picked up, corrosion may also occur.

Experience has shown that maintenance of a pH of 11 or better will satisfactorily control oxygen cell corrosion in a low solids mud system. Saturated lime water functions well in this regard. Its pH can easily be maintained at a maximum of 12.4, and it is inexpensive. If kept free of solids, no oxygen cell corrosion will result, and the pipe will have a thin white coating when pulled.

For some reason, high solids, high pH muds do not fully protect against corrosion. Difficulty in removal of air and entrained gas also is encountered.

The primary trouble that occurred with saturated lime water was in the sloughing of shales. A clear, lime saturated non-ionic, oil-water emulsion was found more successful in preventing hydrous disintegration of shales, but severely hindered the ability to remove cuttings from the hole.

Control of shale. One of the big, unsolved problems of aeration drilling is in prevention of the sloughing of shale. In long, shaley sections, hole enlargement due to sloughing prevents the continuous use of maximum air-liquid ratios. Under such conditions, the liquid rate must be increased in order to sweep the cuttings and falling material from the hole. This in turn tends to nullify the benefits from low-pressure drilling and limits bit performance.

The ideas and assumptions regarding the nature of shale sloughing and hole enlargement are many but the supporting facts that are so necessary to a total understanding of the problem are few. However, the field trials have indicated that three steps will be needed for control over sloughing:

1. Use a liquid that will protect against corrosion, and will not cause hydrous disintegration of shales.
2. Keep a uniform pressure on the formations that are penetrated. Do not fill the hole prior to trips.
3. Improve the cutting carrying capacity of the two-phase system.

Water. Weeping zones can be penetrated without difficulty with aerated mud drilling. However, the prolific water zones present as much a problem to aerated mud as to air or gas drilling and for the same reasons. These are: (1) Water disposal at the surface, (2) slowing of penetration rates by the increased hydrostatic head, and (3) the corrosion problem caused by the influx of water which makes it impossible to add enough lime to keep the pH above 11.

Future of Aerated Mud Drilling

The future of aerated mud drilling as a method for increasing penetration rate and bit life is dependent upon two developments — solving the problem of sloughing shale and increasing the cutting carrying capacity of the mixture. However, aerated mud can be used for balancing off severe lost circulation zones. The term "balancing off" means the introduction of just enough air to lighten the mud column thereby preventing the loss of mud to the thief zone. Since the mud densities required usually range in the 6 to 7 lb per gal range, a small, high pressure-low volume compressor and a rotating head are all the equipment necessary for this type of operation.

To overcome the problem of having to seal off the zone and establish circulation before running casing, the aerated mud can be circulated ahead of the cement to insure a good cement job. By the use of this method, considerable savings can be made in downtime, lost circulation materials, and lost mud.

Acknowledgment

The authors wish to express their appreciation to Phillips Petroleum Company for granting permission to present this paper.

References

1. "Effect of Mud Column Pressure on Drilling Rates," A. S. Murray and R. A. Cunningham, AIME, Petroleum Branch, *Trans*, Vol. 204, 1955, Pages 196-204.
2. "Volume Requirements for Air or Gas Drilling," R. R. Angel. Paper to be presented at fall meeting of the Petroleum Branch of AIME, Dallas, October 7-9, 1957.
3. "Water Still Poses Tough Problem in Drilling with Air," A. S. Murray and S. P. McKay, *Oil & Gas Jour*, June 10, 1957, Pages 105-112.

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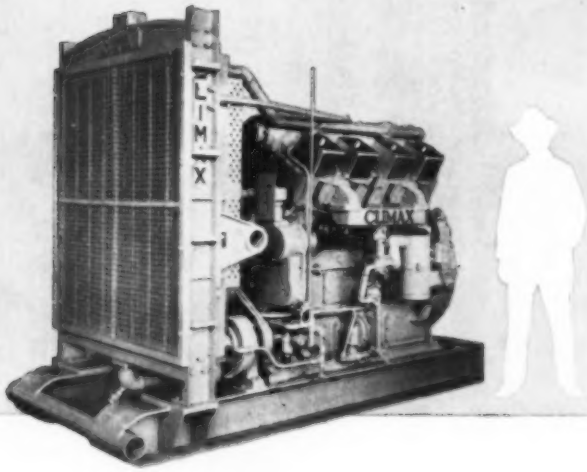

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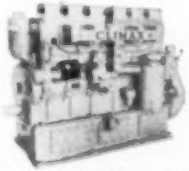

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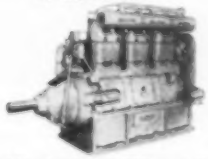

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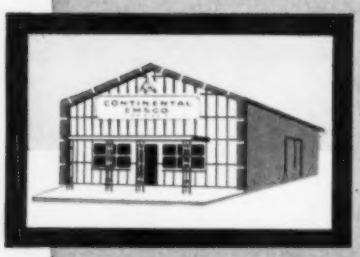

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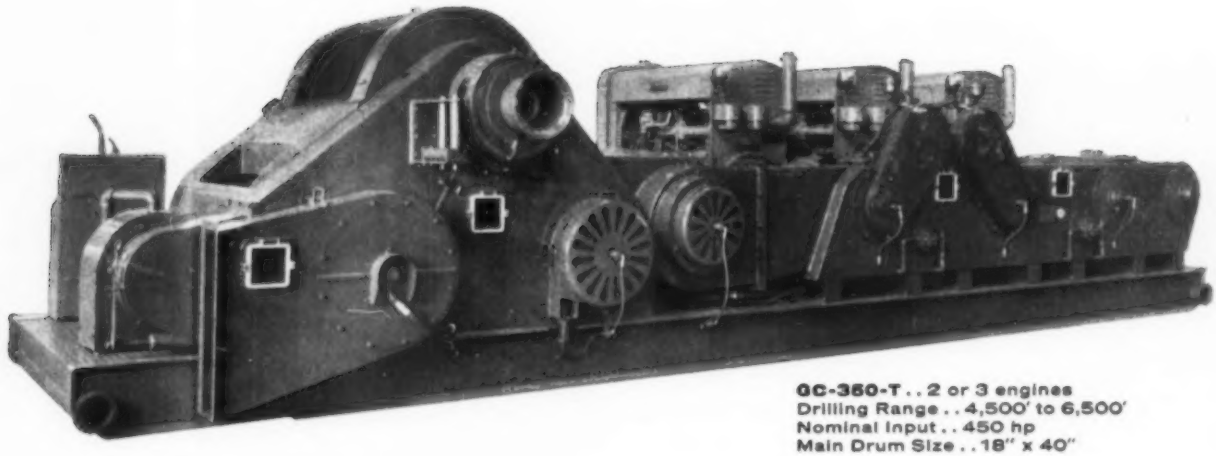

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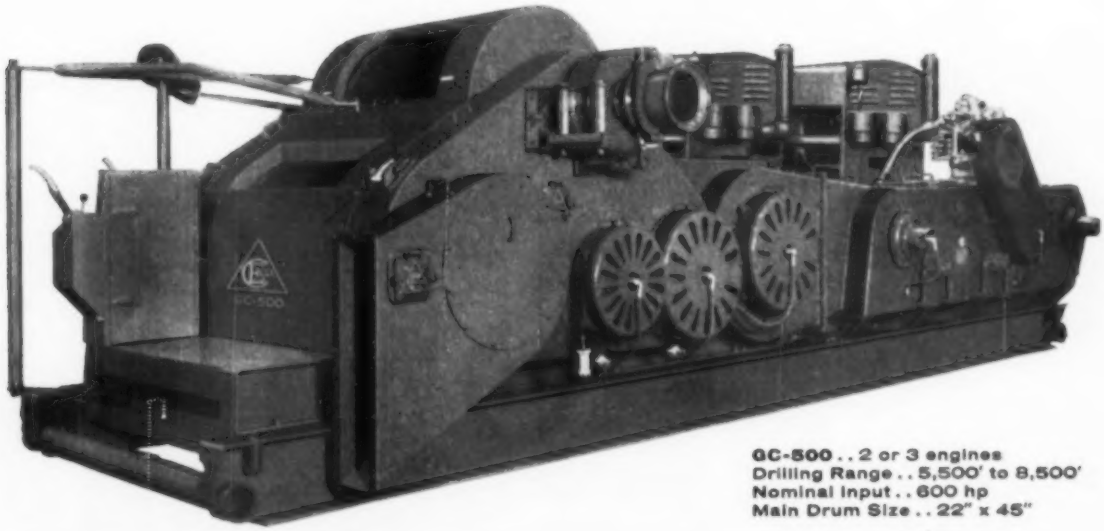

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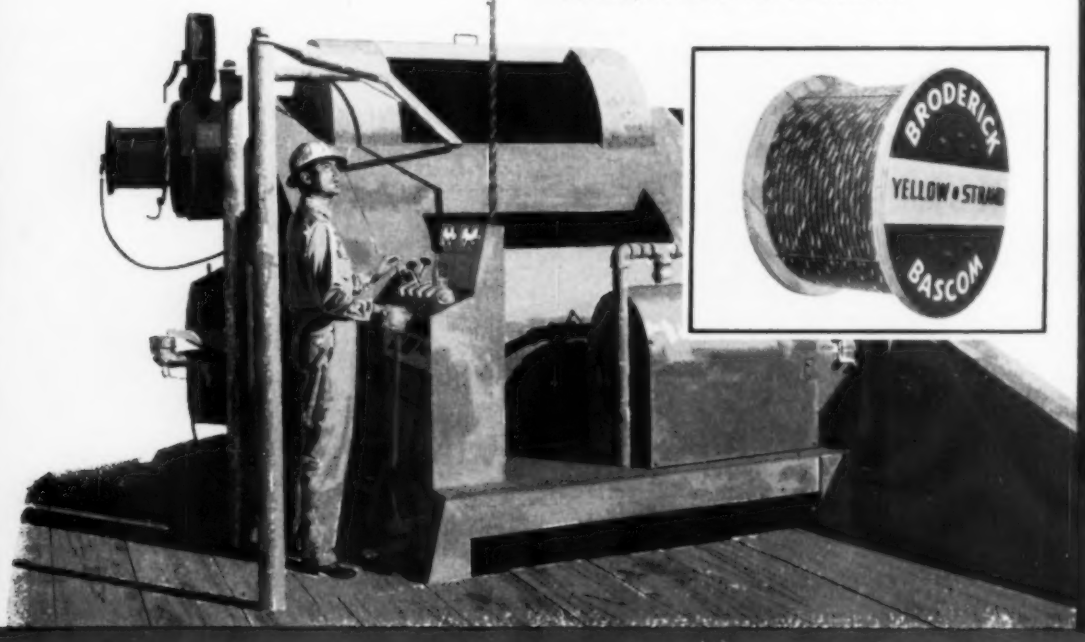

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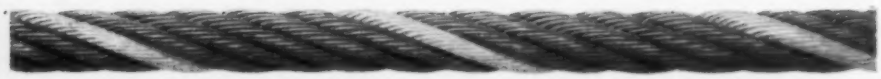

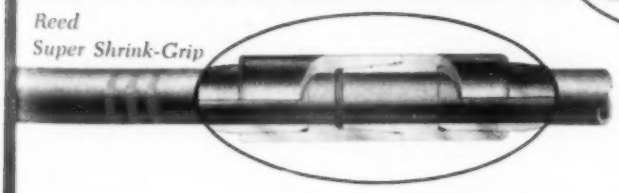

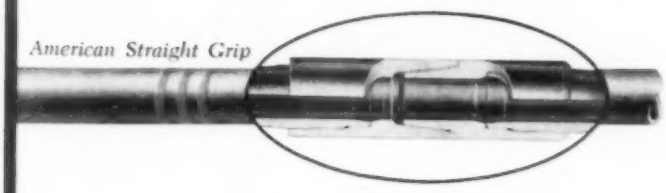

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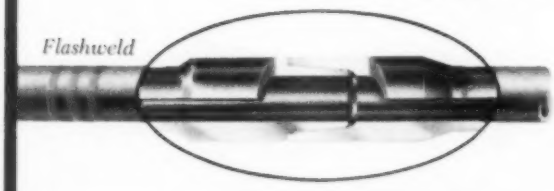

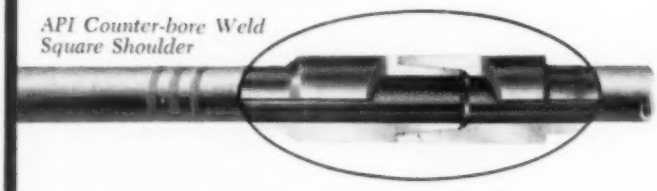

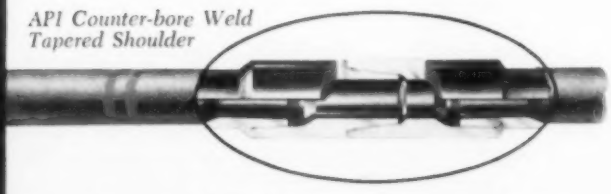

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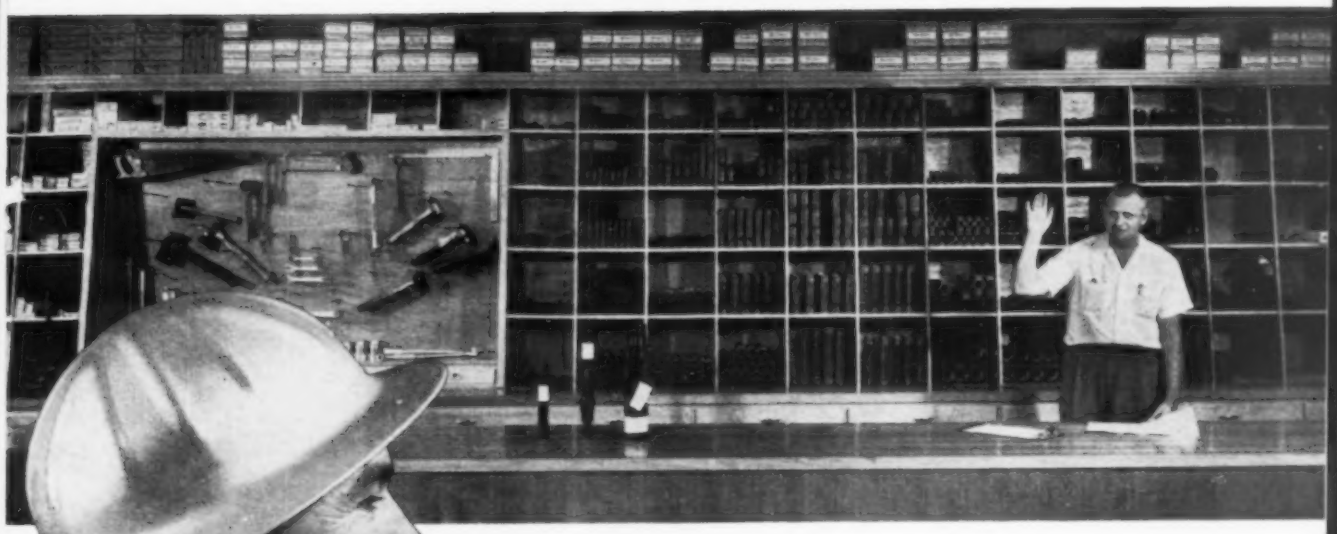

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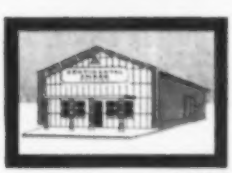

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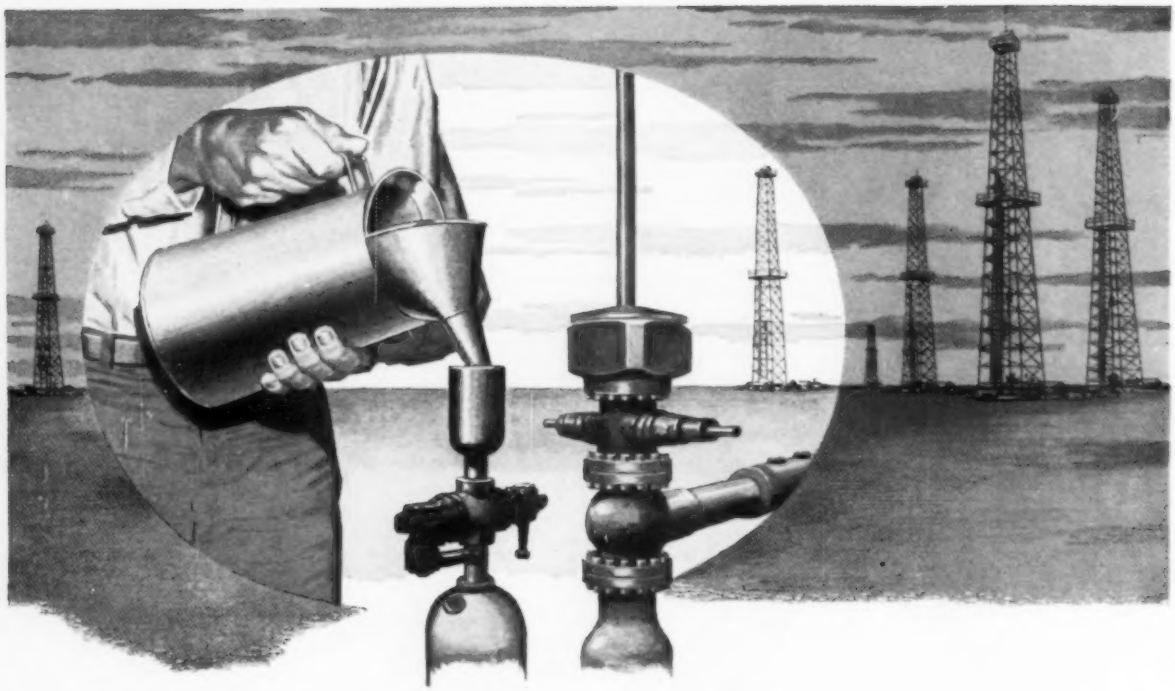

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CONTROLLED DIRECTIONAL DRILLING

James A. LeVelle*

CONTROLLED directional drilling is the art of drilling a well to a predetermined underground target or location. Concurrently, this is the fundamental of *all* modern drilling — whether it be a bore hole held as close as possible to the vertical or a deliberately planned deviation from the vertical. In either of these categories, the mechanical principles of application are basically the same.

In earlier days, directional drilling was used primarily as a remedial operation either to side-track junk tools, bring the bore hole back to vertical or applied to the drilling of relief wells. Today's concepts and methods of oil recovery have so broadened its scope as to separate it from the original objectives and given it a clearly defined field of its own. Where the target is located immediately below the rig, the industry now refers to it as straight-hole drilling and where necessary, directional methods are applied as a corrective measure.

In its own field, directional drilling is now defined as a preplanned operation to drill a bore hole to an underground target whose location is a given lateral distance from the vertical.

Contemporary economics of oil recovery have dictated the progressive development and continuous refinement of controlled directional drilling. Today, we find it applied in addition to its remedial field, in six other production situations that make it economically feasible and desirable.

These basic applications are outlined as:

1. **Offshore drilling** in which an optimum number of wells are drilled directionally from the same platform or artificial island. In the majority of instances, only one vertical well may be drilled from any one platform. It is obvious that if only one vertical well were possible per platform, drilling and production costs would be excessively high. Directional drilling has helped to greatly cut these platform and production costs through the drilling of a number of wells from the one location.

A variation of this application is the T-head, a man-made island from which a number of directionally drilled holes are employed for optimum formation penetration.

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2. **Onshore drilling** for underwater formations has been very successfully used on the West Coast. In the Huntington Beach, California, area some 460 wells have been directionally drilled with borehole deviations as high as 70° from the vertical. Lateral distances of up to two miles have been attained.

3. **Inaccessible location** of producing formation dictates remote rig location and directional drilling. Production may be located under plants, surface tanks, etc., not feasible to move.

Into this category also falls the problem of rig location versus production where the latter may be under a river bed, mountains, harbors, roads, etc. In some cases when difficulty is found in obtaining rig locations, multiple wells are drilled from one location in a manner similar to that used in offshore applications.

4. **Salt dome exploration** has given directional drilling a fertile field of application. The two most prominent types of domes, the deep-seated and piercement, have been thoroughly explored and where possible, brought into maximum production by carefully planned and executed controlled directional drilling programs.

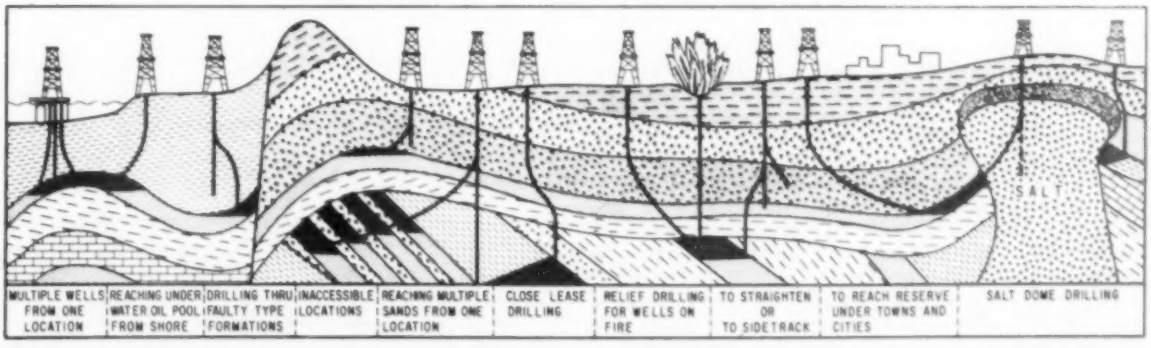
5. **In formation tilt and fault control,** directional drilling is employed to facilitate more economical drilling programs in the former by following the natural drift of formation or well deflection to bottom hole at the desired subsurface location.

In fault control, the well may be deflected across or parallel to the fault to better production.

6. **Stratigraphic trap exploration** finds directional drilling extensively used to explore the oil-bearing formation when the original vertical well bored into water or gas. Well is then plugged back and deflected in an attempt to bottom out in the oil strata.

To complete the list, mention again should be made of its remedial or corrective applications: Side-tracking lost tools, straightening crooked holes, etc., and drilling relief wells to relieve a blow-out.

These techniques reflect the lowest and highest precision uses of directional drilling. Side-tracking and straightening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RELIEF DRILLING FOR WELLS ON FIRE
TO STRAIGHTEN OR TO SIDETRACK
TO REACH RESERVE UNDER TOWNS AND CITIES
SALT DOME DRILLING

FIG. 1. Once a remedial operation, controlled directional drilling is now applied to many problems encountered in drilling for production.

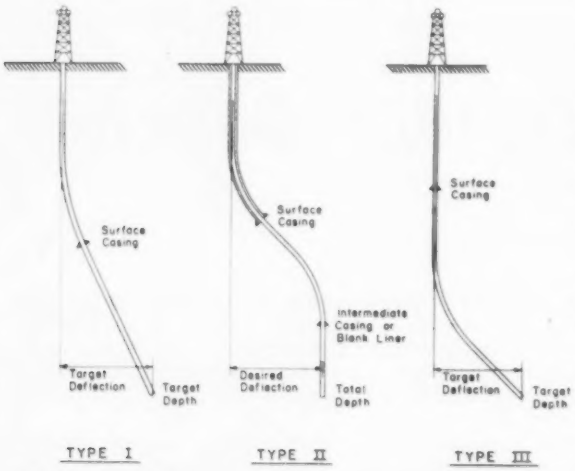

FIG. 2. Three basic types of hole configuration are employed in directional drilling programs. Type selected for any one well program is dependent on formation and well conditions.

operations usually enjoy rather slack tolerances both with respect to angle and direction. Short distances and limited time of operation reduces need for stringent controls. On the other hand, the drilling of relief wells requires extensive control both of deviation and direction. Since the relief well must bottom as near the bore of the burning well as possible, considerable planning and accurately controlled drilling must be utilized throughout the drilling process. Due to relatively large distances, close tolerances are required.

Some directional drilling is used to a limited extent in the Rocky Mountain area as a means to obtain more open hole area in the production strata. The bore hole is drilled on a slant to get more hole area in tight, narrow formations found in this area.

Types of Directionally-Drilled Holes

In introducing the discussion on types of deviated bore holes, it must be pointed out that the choice of a particular type to fit a given drilling problem involves many complex factors. In a preplanned, deflected bore hole, a carefully conceived and executed drilling program based on geological information, knowledge of and the selection of the right tools, mud and casing programs and circulation of target point with casing program and rig location — may insure optimum success of the venture.

Actual experience over the recent years has patterned controlled directional drilling to three types. Practically all deflection-drilled holes will fit one of these types or a combination thereof.

Type I is planned so that the initial deflection angle is obtained at a shallow depth and from that point on, the angle is maintained as a straight line to the target zone. In practice, the hole is spudded to a depth in excess of 100 ft and the hole below this point deviated to the proper angle and direction. Once the angle and direction is obtained, surface casing is set through the deviated section and cemented to act as a "bearing" for subsequent drilling operations.

Type II also sets the initial deflection angle near the surface. After the angle is set, drilling continues on this line until horizontal or lateral distance from the vertical is attained. The hole is then returned to vertical and drilled so until objective depth is reached.

Surface casing is set and cemented as in **Type I** — after the desired deflection angle is reached. Intermediate casing is set and cemented after the hole has been returned to vertical.

Type III starts its deviation well below the surface. The angle is then maintained to target point.

Only generalization can be applied where the drilling or production problem is to be correlated to type of hole configuration. As previously stated, a number of complex factors govern either the selection of a pattern type or the successful completion of a directional drilling program. Thus, many of the problems encountered often require adaptation of a pattern or combinations so as to make the problems and treatments quite individual.

Generally speaking, Type I is employed in moderate depth drilling in areas where intermediate casing is not required and where oil-bearing strata is a single horizon. Type I is less expensive than Types II or III for several reasons and is possibly the simplest to complete.

Deflection is made at a shallow depth and thus trip time for whip-stocking, surveying, etc., is appreciably less than for other types. The curved portion of the bore hole can be readily cased also for prevention of key seats.

The deflection angle is considerably less, too. To its possible disadvantage is the fact that directional-drilling operations must be maintained through a large part of the drilling time. Difficulty in accurate logging interpretation has been encountered also. This is chargeable generally to the borehole angle.

Type II is employed on deep wells in areas where gas troubles, salt water flows, etc., dictate the setting of intermediate casing. Also, it permits more accurate bottom-hole spacing in multiple pay areas. Deflection angle may be set in surface zones where drilling is fast and round-trip costs can be held to minimum. When hole is returned to vertical and intermediate casing set, directional operating crew can be released and straight-hole drilling practices followed to completion of hole.

To some extent, it does eliminate logging interpretation problems encountered in Type I and does allow a vertical hole into the producing horizon. But, it also imposes high angles and a double reversal in the drill string. Possibilities of dog-legs and key seats are increased if casing is not set in straightening-out portions of hole.

Type III is used in multi-pay fields where multiple completions are not desired. Deflection angles may be relatively high and lateral distances from vertical line to

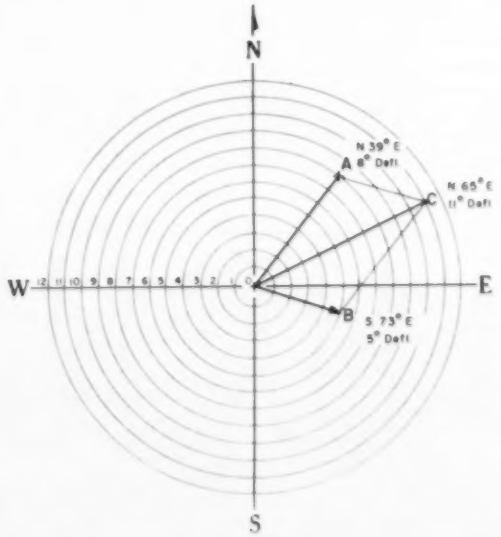

FIG. 3. Graphic techniques and plotting are used to determine whipstock settings and chart the projection of the hole. As shown, whipstock setting is obtained readily by closure of the triangle AOC.

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FIG. 4. Trade mark of the directionally drilled hole, the retrievable whipstock shown is used almost exclusively in modern directional operations.

desired penetration point relatively shorter than the other types.

Typical application would be exploring a stratigraphic trap or obtaining additional geological data on a dry hole.

Since deflection operations take place deep in the hole, trip time for such operations are high and the deflected part of the hole is not normally protected by casing.

Mechanics of Directional Drilling

While the whipstock is the symbol of directional drilling, the major drilling activity is accomplished with conventional drilling tools. Whipstock operations are used to initiate deflection or make major corrections in the direction of the hole. Conventional techniques and principles are employed to maintain or control angle and direction during the projection of the well.

The objective of the conventional drilling operation is to maintain the direction of the project hole along a predetermined course with the most favorable drilling rates permissible. Since drilling rate is a function of weight, rotary speed and circulation rate, all of which also affect directional tendencies of the bit, conditions must be compromised to permit optimum directional control with acceptable drilling rates.

Directional Tendencies of Drilling Strings

The tendency of the bit to drift is a function of the drilling string characteristics formation dip and direction, weight applied to the bit and to some extent the rotary speed.

In conventional drilling, weight applied to the bit has the same reaction on the lower part of the drill collars as end loading on a column. When little or no weight is applied, the drill collars hang straight. As weight is applied, the column flexes until the drill collars contact the wall of the hole. Additional weight results in this point of contact traveling down-the-hole closer to the bit. The angle formed by this point of contact and the clearance between the drill collars and hole approximates the change in direction or deflection that would accompany the next increment of hole drilled. From this it follows that the higher the bit weight, the greater the tendency of the hole to be deflected.

In vertical or near vertical holes, the direction and magnitude of this deflection is unpredictable. In high angle hole, the point of contact will in the majority of cases be on the lower side of the hole with the result that the change in deflection is additive and tends to increase hole deflection. Increasing drill collar sizes, moderate bit weights and higher rotary speeds are used to reduce this tendency. Small drill collars, high weights, etc., are often used where it is desired to increase drift tendencies.

Effect of Formation Dip

There is definite indication that the dip of formations has a pronounced effect on the direction of drift. While each area has its own characteristics, certain general tendencies have been observed. Where alternately hard and soft formations are being drilled with a well stabilized sharp bit and weights high enough to cause drill collar flexure, travel will tend toward a course perpendicular to the bedding plane of the formations.

Where the opposite bit conditions exist, i.e., dull bit, low bit weight and stability, the reverse effect seems to be true and the bit will tend to slide or track into the softer formation and in the down slope direction. This latter condition is particularly prevalent where the angle of incidence of the bore hole with bedding plane is high.

Where thick formations are encountered or where the degree of hardness between formations is small, the effect of dip on the direction of drilling is negligible.

Well programs can be planned to take advantage of these characteristics where data is available. These tendencies are also utilized in controlling the progress of the well bore. High bit weights are used often to increase deflection. A limber drilling string, reduced bit weight and a sharp course tooth bit with an acute edge angle is used in many areas to reduce the deflection angle when the drift of the hole exceeds the bedding plane angle of the formation.

Use of Reamers and Stabilizers

In recent years reamers and stabilizers have been added to the line of useful tools for directional drilling. In effect they may be used to minimize or exaggerate as needed the characteristics of a conventional drill collar string. Placed near the bit, these tools act as the point of contact or fulcrum to increase the angle of the bit with respect to the bore of the hole. Properly placed in the string they may be used to maintain the angle of the hole or under some condition utilized to decrease the hole angle.

The point of tangency as well as the proper placement of reamers and stabilizers is dependent upon the OD of the drill collars, diameter of the hole, rotary speed and weight on the bit. (The Wood and Lubinski charts presented at the Mid-Continent District Meeting, API, March 1954 and 1955 are excellent aids in selecting stabilizer points.)

Basically stabilizers are used in three types of operations in directional drill.

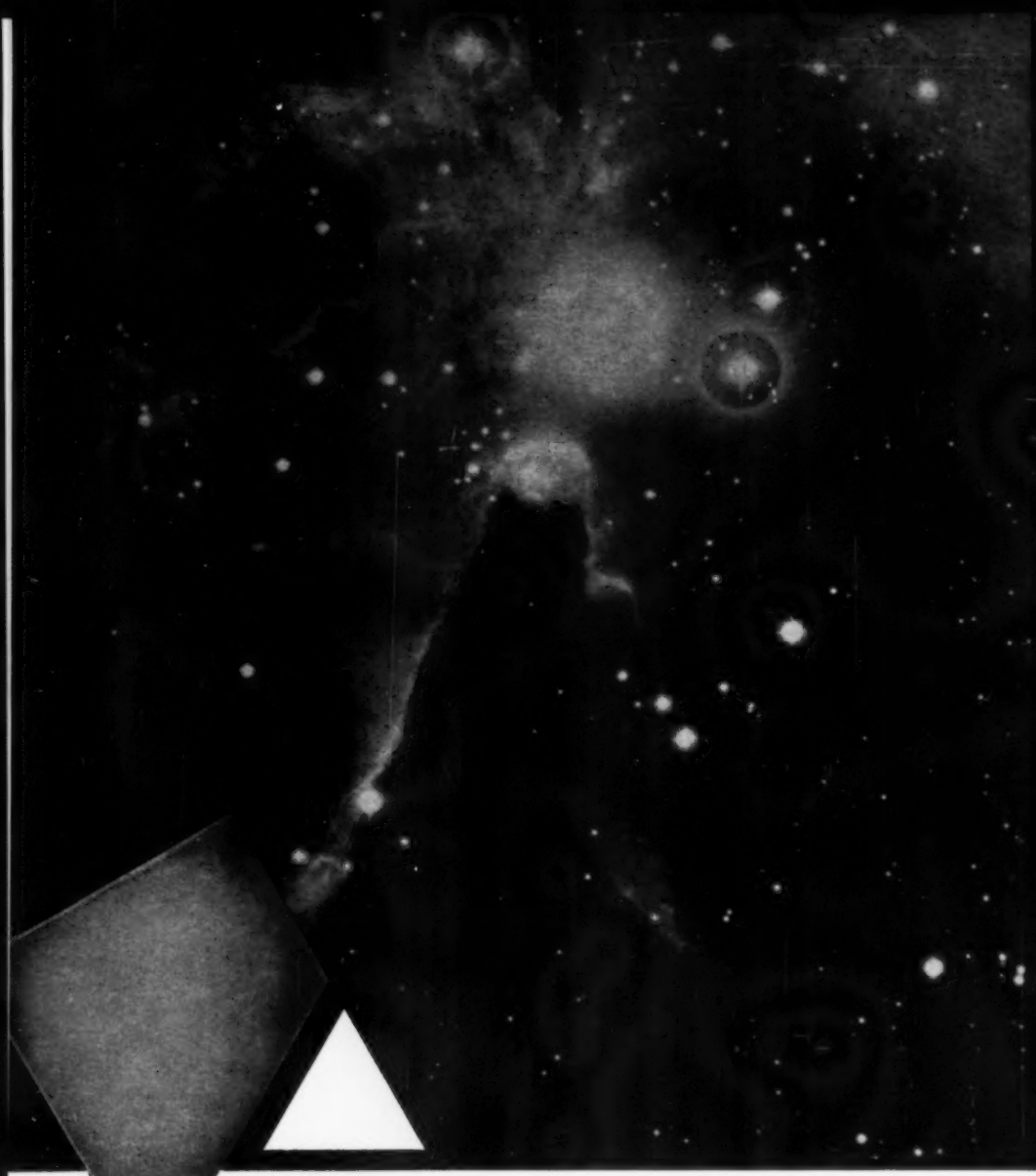
1. It is used as a fulcrum by placing the stabilizer or stabilizers just above the bit to produce high angles.
2. They are placed at an optimum point above the natural point of tangency to produce a hole straightening effect or reduce hole angle.
3. Stabilizers are placed accurately in the drill collar string to maintain hole angle during the drilling operation.

In this latter condition one operator recommends the use of one stabilizer for every two drill collars where the hole angle is less than 30 deg and one stabilizer per joint where the angle exceeds 30 deg.

Theory of Whipstocks

As previously stated the role of the whipstock in directional-drilling operations is primarily that of correcting the course of the hole and the initiation of large deflections in the drilling program. Simple in design, its effective application approaches the complexity that is associated with other drilling tools.

Essentially the whipstock is a wedge which deflects the bit from its previous course. However, the hole drilled and the ultimate deflection and direction obtained in subsequent drilling operations is not that of the wedge angle alone. In practice three vectors or angles are required to determine the ultimate change in direction that will be obtained with any one whipstock setting. These are: The angle of the face



The "Cone Nebula" in the constellation of Monocerus photographed through the 200-inch Hale telescope of the Palomar Observatory. This mass of stars is about 1,000 light-years, or roughly six million billion miles from the earth.

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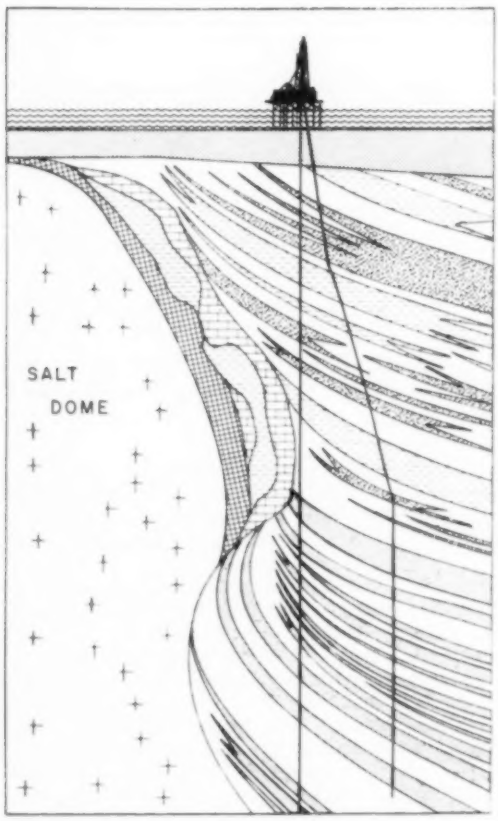

FIG. 5. Through the drilling of several wells from a single platform directional drilling is applied to reduce location costs. Typical use shown above is being used to develope saltdome type production in the Gulf of Mexico.

of the whipstock; the "roll-off" angle which is a measure of the tendency of the bit spin off of the face of the tool and the "follow up angle" which is caused by the drill string tending to flex at the point of change and the enlargement of the hole in the whipstocked section. This latter angle may take effect in the first 50 ft or in some cases over several hundred feet of hole.

While the angle of taper of the face of the whipstock can be readily measured, the other two angles are functions of the individual tool and formation characteristics. Normally they may be reasonably defined in the various areas, such that their effect can be used in making settings.

"Roll-off" generally effects the direction taken by the bit but does not alter the angle. As a result of this it is applied as a correction in orientating the whipstock face. "Follow-up" has little or no effect upon direction but normally adds to the deflection angle provided directly by the whipstock. This effect is projected over the subsequently drilled hole and is affected by the reamer and drilling assemblies used. In practice the total angle that will be delivered by the one whipstock setting is used in determining the setting.

Graphic methods are used to determine proper whipstock settings. The overall deflection angle is used in the solution and consists of face angle and follow up angles. The "roll-off" angle is applied as a correction.

In Fig. 3, A represents the angle and direction of the hole and C the desired conditions for further drilling. Closure of the triangle AOC shows that a setting of S73E would be required to obtain this change and a deflection of 5 deg would be desirable. Assuming that the roll-off angle is one degree to the right, the setting would be made with the whipstock facing S74E to allow for this tendency.

Similar constructions may be used to determine multiple whipstock settings and in the solution of other directional problems.

Tools and Their Application

The basic controlled directional drilling tool kit consists of the retrievable whipstock, pilot reamer, non-magnetic tool joint and the single shot directional survey instrument. Special adapters and subs used in conjunction with these tools complete the kit.

Whipstock

Basically the whipstock is a tapered or wedge-shaped steel casting with a groove on the wedge side which will deflect the bit to the desired angle. At the top of the device is a ring providing a guide through which the drill pipe revolves and by which the whipstock is retrieved. The bit used is smaller that the gage of the bore hole. For example, 8⅝-in. bits are the largest that can be used in 10⅝ to 14¾-in. holes.

In actual practice, the whipstock is selected for the desired deflection angle (maximum permitted being about 4 deg), bolted to a special sub just above the drill bit and run to the bottom of the hole. The desired direction is then set by orienting with instruments or a magnetic sub. Some operators have used a method of setting with tools on the surface using a transit. The latter method is considered the least desirable and is inaccurate below 5000 ft.

After the whipstock is set in the hole, the bottom-hole orientation tool is run and set in a special sub just above the whipstock assembly. The instrument measures the vertical angle or low side of the hole, the position of the face of the whipstock relative to the low side of the hole, and the horizontal angular differences between tool face and the face of a magnet in the orienting sub.

The orienting tool is then withdrawn, readings taken and correlated to determine the correct rotation of the whipstock assembly for desired alignment. The instrument is then rerun for a final check on the whipstock.

After checking and pulling orienting tool, weight is applied on drill string to shear the pin holding bit to whipstock and the small diameter bit then drills a rat hole to deflection angle for a distance of 10 to 20 ft.

The whipstock assembly is then withdrawn and the rat hole reamed to full gage with a piloted reamer. Upon completion of the reamer run a single shot survey instrument is dropped into the string which lands in a non-magnetic collar located in the reamer string. This is done to check the new deflection and direction.

If found satisfactory, a conventional drill string is run to drill ahead. If unsatisfactory, whipstock operations are repeated until the correct direction and drift is obtained.

Surveying

The non-magnetic drill collar and the single-shot survey instrument form a single component in the directional kit. Since direction is obtained by magnetic means, the non-magnetic collar or sub is used as the landing sub for the survey instrument. It is normally run just above the bit to provide the most accurate information on deviation.

Non-magnetic collars have the same diameters as a conventional steel collar but are normally manufactured from "K-Monel" which has a magnetic permeability roughly equivalent to that of air. Used in 18 to 30 ft sections, it permits the operator to obtain a true magnetic compass bearing at the bottom of the hole. "K-Monel" drill collars have mechanical properties comparable to SAE 3140 and 4140 steels which are presently used in conventional drill collars.

The single-shot survey tool makes a record of the angle

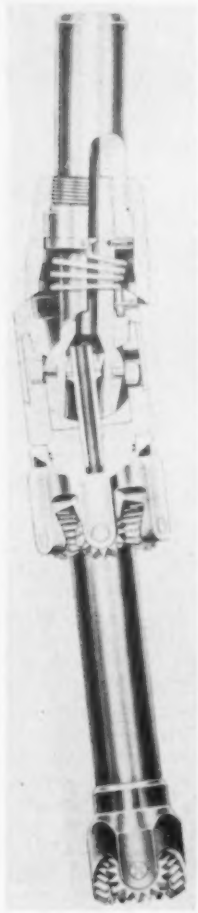

FIG. 6.

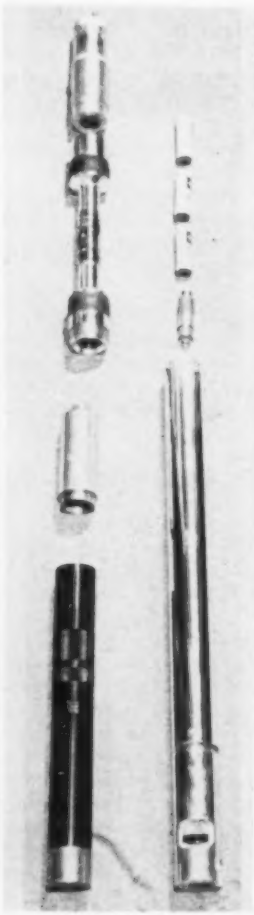

FIG. 7.

FIG. 8.

FIG. 6. Full gage hole deflectors have found only limited use in deflecting wells due to difficulty of controlling direction. This assembly is used to follow-up whipstock settings where a considerable increase in deflection is desired.

FIG. 7. Components of the single shot survey instrument. Units include camera, plumb bob, and magnetic compass.

FIG. 8. Single shot survey tool made up into a go-devil with a feather type head. Unit lands in non-magnetic collar and is retrieved when the drill string is pulled.

of inclination and a compass reading showing the direction of the angle. Instruments are dropped into the string for seating in non-magnetic collars or subs, or may be run on wireline. Other techniques include open-hole, surveying, dropping through core bits, etc.

Fundamentally the tool consists of a pendulum or other method for indicating the vertical, a magnetic compass, timer, light source and photographic section. Most popular practice is to run instruments in a go-devil assembly which is dropped into the string. This unit sets in the non-magnetic collar and is retrieved when the drill pipe is pulled. Single shot instruments are constructed to have ranges 0° to 10°, 0° to 20° and 15° to 90°.

Concept of the Project

It has been previously stated that a controlled directional-drilling project is so concerned with a number of factors as to very nearly be an individual undertaking each time one is planned and developed. In conceiving a project seven basic factors must be carefully correlated. These are:

1. Accurate as possible geology including, if possible, operator's personal experience and knowledge of area to be drilled and known drilling hazards.
2. Casing program.
3. Surface location of rig.
4. The target or bottom-hole location accurately correlated to items 2 and 3.
5. If more than one well is to be drilled, spacing requirements are to be considered.
6. The mechanical job of drilling, itself, including careful selection of tools and their operating capacities.
7. Mud programs.

Due to the greater wall forces involved and the longer drilling time, hole conditions should be maintained as best possible. Mud and casing programs are individual bore hole and geological requirements. Detailed discussion of such is outside the scope of this treatise.

However, it could be noted that a number of operators indicate that an extra-tough filter cake forming mud with rapid cake replacement is mandatory to the program. Oil emulsion muds have found favor in reducing drillpipe friction, particularly where high deflection angles are required.

As indicated previously, directional drilling is normally more expensive and time-consuming than conventional vertical. However, under some circumstances directional wells have been found less expensive and are being applied for this purpose. With the increasing use of controlled directional drilling, new and better tools are being developed. Improved methods will undoubtedly result in reducing the cost of this type drilling.

Hole troubles are more frequent. Drill string sticking seems to be the greatest hazard with stuck pipe occurring about twice as often. Penetration is slower (some average 20 percent less than in vertical wells).

The selection of kick off points is dependent both upon the hole type and formations present. The preferable points at which to commence deviation of the hole should be at a juncture where formations are relatively thick and more or less uniform in drillability. Moderate to medium hard formations yield best results. Soft shales and poorly cemented sands prove difficult and enhance opportunities for key seating troubles and poor whipstock drilling and reaming.

As previously remarked, highly tilted and faulted horizons containing alternately hard and soft streaks are to be avoided until desired angle of deviation and hole direction is attained.

The aforementioned paragraphs only generally cover controlled directional-drilling factors and a resume of some difficulties to be expected in the project.

That it is economically feasible and desirable in its planned field of application is self-evident. In these specialized applications, it is now considered an indispensable production and exploration technique. As tools and techniques improve, its costs will undoubtedly lessen and its fields of application broaden.

References

1. "Techniques of Drilling and Producing High Drift Angle Directional Wells," Daniel S. Johnston and James T. Carriel. A report by Signal Oil and Gas Company.
2. "Directional Drilling in the Los Angeles Basin," D. L. Roberts, API Drilling and Production Practice 1949, p. 60.
3. "The Fundamental Mechanics of Directional Drilling," F. A. Gaser. API Drilling and Production Practice 1949, p. 71.
4. "Use of Stabilizers in Controlling Hole Deviation," H. B. Woods and Arthur Lubinski. API Drilling and Production Practice 1955.

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College Professors Visit Venezuela

Eight college professors, specialists in petroleum refining, petroleum engineering and geology, have just returned from a visit to Venezuela's oil fields as the guests of Creole Petroleum Corporation, largest oil producer in Venezuela.

The educators who participated in the tour include: J. O. Ball, professor of petroleum refining at Colorado School of Mines; W. B. Bleakley, professor of petroleum engineering at Tulsa University; H. G. Botset, professor of petroleum engineering at University of Pittsburgh; C. G. Dodd, professor of reservoir engineering at University of Oklahoma; W. L. Ducker, professor of petroleum engineering at Texas Technological College; V. B. Monnett, professor of geology at Oklahoma State University; C. A. Moore, professor of geology at University of Oklahoma; and E. V. O'Rourke, professor of petroleum engineering at Ohio State University.

The visit was made by Creole as part of the company's long range program to acquaint an increasing number of the nation's leading educators in the petroleum technological field with progressive operational policies and methods now being used in oil production and refining in Venezuela.

The group of educators who departed for Venezuela in early August returned to the United States August 16. They visited installations in the Bolivar Coastal field (Lake Maracaibo), Creole's Amuay refinery on the peninsula of Paraguana, the oil fields in eastern Venezuela and Creole's headquarters at Caracas, capital city of Venezuela.

U. S. Bit Manufacturer Opens Plant in Holland

Formal opening ceremonies of the Reed Roller Bit Company (Nederland) N. V. rock bit manufacturing plant at Leiden, Holland, have been held. Reed N. V., wholly-owned subsidiary of Reed Roller Bit Company of Houston, Texas, is this company's first oil tool manufacturing expansion outside the United States.

Production of the new Reed "Y" series three-cone bits, by the new plant will supplement Reed's Houston production for world-wide distribution.

R. G. Hamaker, president of Reed Roller Bit Company, was in Leiden for the ceremonies. F. L. Tyler, formerly California sales division manager for Reed, is the manager of Reed N. V., and John Workman, former Reed engineer in Houston, is co-manager.

Oil Progress Week and Drilling Progress marked in Tulsa at...

Seventeenth AAODC Convention

Oklahoma's Senator Kerr speaks; contractors hear of latest drilling advancements

Principal Speaker . . .
Hon. Robert S. Kerr
U. S. Senator from Oklahoma, Board Chairman, Kerr-McGee Oil Industries, Inc.

DRILLING ECONOMICS, technology and intra-industry relationships will be prime topics for discussion at the seventeenth annual meeting of the American Association of Oilwell Drilling Contractors. Sessions will be in the Mayo Hotel in Tulsa, Oklahoma, October 13-15.

Plans for the three-day meeting, to coincide with Oil Progress Week, are all completed, announces General Chairman R. E. Kirberger of Service Drilling Company, Tulsa.

Principal Speaker

Senator Robert S. Kerr, D-Oklahoma, will be principal speaker at the contractors' annual banquet at the Cimarron Ballroom Tuesday evening, October 15. Senator Kerr, a member of AAODC, is board chairman of Kerr-McGee Oil Industries, Inc., Oklahoma City. He has been in the oil business since the 1920's, drilling oil wells, first as a side line to his practice of law, and then as a full-time occupation. Kerr was Oklahoma Governor, from 1943 to 1947, and has twice served as a member of the Executive Committee of the National Governors' Conference. He was chairman of the Southern Governors' Conference and the Interstate Oil Compact Commission. He was elected to the United States Senate for a six-year term that began January 3, 1949.

Business Sessions

Registration begins at 2 p. m. Sunday, October 13, with a meeting of the board of directors also scheduled for that afternoon.

General business activities get underway Monday morning. Each of the 12 standing AAODC committees will meet at 9:30 a. m., preceding luncheon in the Crystal Ballroom of the Mayo. Frank G. McClintock, Zephyr Drilling Corporation, Tulsa, will preside at the luncheon, and Dr. E. H. Eckel, rector of Trinity Episcopal Church, Tulsa, will give the invocation. Mayor George E. Norvell will officially welcome the oilmen to Tulsa, "Oil Capital of the World."

At 2 p. m. Monday, the First General Session will be held in the Pompeian Court, with Frank Frawley, Frank Frawley Drilling Company, Tulsa, presiding. The AAODC President's address will be delivered by Jack H. Abernathy, Big Chief Drilling Company, Oklahoma City.

"Supplier and the Contractor"

Rainey Elliott, president of Jones & Laughlin Supply Division, Tulsa, will speak Monday afternoon on "The Supplier and the Contractor." Elliott has been president of the Petroleum Equipment Suppliers Association and is a director and member of the Board of Councillors of the American Petroleum Institute. He also is a director of Tulsa Chamber of Commerce, YMCA and Community Chest, and a trustee of Children's Medical Center and Hillcrest Medical Center.

At the second general session on Tuesday morning, John C. Casper, economics editor of *The Oil & Gas Journal*, Tulsa, will present a forecast of drilling industry activity, B. E. Groenewold, Exploration Drilling Company, Tulsa, will preside.

New Officers

New national AAODC officers will be installed at the luncheon meeting Tuesday. President Abernathy will serve as meeting chairman.

A series of technical papers, reporting on AAODC committee and independent studies of various phases of drilling technology, will comprise the Tuesday afternoon program. Earle Hellums, Gracey-Hellums Corporation, Houston, will preside.

Weight-Speed Report

First on the program is a progress report on the Weight-Speed Penetration study being conducted by a subcommittee of the AAODC Rotary Drilling Committee. An introduction to the report will be given by Elmer Decker, subcommittee chairman and president of Martin-Decker Corporation, Long Beach, California. Rotary speed factor involved in the study will be analyzed by John E. Eckel, director of drilling research, The Carter Oil Company, Tulsa. Henry B. Woods, assistant director of research engineering, Hughes Tool Company, Houston, will discuss the effect of weight.

"Supplier and The Contractor" . . .
Rainey Elliott
President, Jones & Laughlin Supply Division, Tulsa

By Merle Davis—Ralph Foster
Johnston Testers

FOR MORE INFORMATION ON YOUR DRILL STEM TEST

A check-off list for reverse circulating drill stem tests

The practice of reversing out the recovery of a drill stem test made in either an open or cased hole is now being widely used. The success of the practice has been proven with both high and low pressure tests and with both high and low liquid recoveries.

REVERSE CIRCULATION IN PERMIAN BASIN (OPEN HOLE TESTS)

The type A "sleeve" and the type B "knock-off" valves are preferred by the majority of the oil companies in West Texas. The type "B" sub has a slight edge because it can be run down in the drill collars closer to the test tool assembly.

The location of the reversing valves is dependent on the amount of "sample" to be left in the pipe and whether or not drill collars are run on top of the test tool assembly. The type "A" sub must be run above any small I. D. drill collars while the type "B" can be run "down" in the drill collars. It is common practice to separate the hydraulic valve and the shut-in valve (in the basic test tool assembly) by one or two singles—this provides a clean sample of the last fluid the formation produced into the drill pipe. The "sample" recovered above the shut-in tool and below the reversing sub may be slightly contaminated by the mud.

The high viscosity of the mud and the use of lost circulation material in some wells make it advisable to run both types of reversing subs each providing two reversing ports.

The reversing subs are opened *after* the mud pumps are started and mud is being pumped into the annulus. Normally, the difference in hydrostatic pressure (mud outside the drill pipe and oil, gas or water inside the pipe) will reverse almost all the fluid produced by the formation. In order to complete the reversing operation, the rams can be closed and *moderate* pressure applied to the hole. Extreme care must be used in pumping into the open hole to prevent breaking down a formation and causing lost circulation.

After reversing, the pipe can be pulled dry because the mud (which replaced the formation fluid) will drain back through the reversing sub ports.

Reverse circulation check off list

Before operating reversing valve

- ☐ Pump running
- ☐ Mud line valves positioned to divert mud flow to annulus
- ☐ Rams and/or Hydril checked for operation

Operating Reversing Valve (Type A and/or Type B)

- ☐ Close well in at surface
- ☐ Disconnect high pressure steel flow hose
- ☐ Close shut-in tool by rotating
- ☐ Reconnect high pressure steel flow hose
- ☐ Bleed down drill pipe (if go-devil hanger not used)
- ☐ Check mud in annulus (*must stay full* throughout reversing operation). Packer may be pulled loose if shut-in period is completed
- ☐ Drop proper go-devil to operate reversing sub
- ☐ Close surface valve (keep closed as long as annulus is *not* full)
- ☐ Control flow of recovery with surface valves so that hole remains full of mud.

NOTE: If reversing stops, apply moderate pressure to annulus or apply moderate pressure to tubing or drill pipe until normal circulation is barely established then go back to reverse circulation.

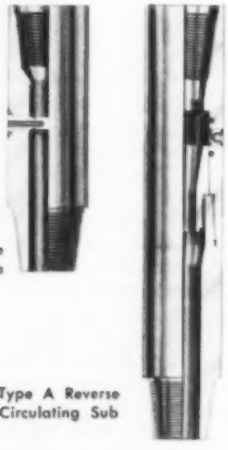
When natural reversing is completed or to speed reversing procedure

- ☐ Close rams or Hydril
- ☐ Apply moderate pump pressure to annulus
- ☐ Stop pumps when clean mud of normal weight is reversed
- ☐ Remove flow head and come out of hole at proper speed (prevent swabbing). Pipe should pull dry.

A supplemental article on Reverse Circulation in the Gulf Coast area is now being prepared. Look for it in this publication. For complete information on Reverse Circulation write Johnston Testers, Houston, Texas.

Merle Davis
Dist. Mgr.
Crane, Texas

Ralph Foster
Dist. Mgr.
Snyder, Texas



Type B Reverse Circulating Sub

Type A Reverse Circulating Sub

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FORMATION AND CASING TESTING — JOHNSTON

John E. Eckel
Director of Drilling Research
The Carter Oil Company
Tulsa, Oklahoma

Henry B. Woods
Ass't Director of Research Engineering
Hughes Tool Company
Houston, Texas

Elmer Decker
President, Martin-Decker Corporation
Long Beach, California

Decker, for several years active in contract drilling in Texas, Oklahoma and California, was co-founder with W. R. Martin of Martin-Decker Corporation in 1928. Since that time his prime interest has been in the development of instrumentation of oil well drilling. Decker was the founder of NOMADS and an early vice president in the California Petroleum Production Pioneers. For years he was active in the Production Division of the American Petroleum Institute. An Associate Member of the American Association of Oilwell Drilling Contractors, Decker has been active in AADC work from its inception.

John Eckel, who will discuss the rotary speed factor, has served as senior engineer in equipment investigations for Humble Oil & Refining Company in Houston, Texas, and has been vice president in charge of engineering for Oil Center Tool Company. He assisted in the formation of Petroleum Mechanical Development Company in 1949, and in 1951 joined Carter Oil Company's research department.

Effect of weight in this study is discussed by Henry Woods. He has been a Hughes Tool Company employee since 1925. He has held positions as chief chemist, testing engineer and laboratory director. Since 1945 he has been assistant director of research engineering with offices in Houston.

Air and Gas Drilling

Findings of the AADC-API joint study of air and gas drilling will be reported by M. M. Brantly, president of Brantly Drilling Company, Inc., Midland, Texas. His firm operates eight rotary rigs in the Permian Basin area, and in 1956-57, he served as AADC vice president for the basin area. Formerly associated with Drilling and Exploration Company, Inc., he organized the Brantly Drilling Company in 1952.

Magnetic Brake

Final paper on the Tuesday afternoon program will be presented by E. A. Studer, chief engineer with the Baylor Company, Inc., Houston. His subject is " Applications of the Magnetic Coupling and the Magnetic Particle Brake."

Before joining Baylor in 1957, Studer was district engineer in Odessa, Texas, for Continental Supply. His first work with Baylor was as sales and service engineer for the Mid-Continent and Gulf Coast areas. He formed his own company, The Easter Company of Odessa, in 1951, with the primary interest of sales and service of Baylor Company products. He assumed his present duties with Baylor in February, 1957.

Banquet

Concluding event of the meeting will be the Annual Banquet Tuesday evening, at which Senator Kerr will speak. General Chairman Kirberger will preside, and Tulsa Attorney Pat Malloy will be toastmaster.

Special entertainment for the ladies includes a luncheon and style show at noon Monday.

Air and Gas Drilling . . .
M. M. Brantly
President, Brantly Drilling Company, Inc.
Midland, Texas

Magnetic Brake . . .
E. A. Studer
Chief Engineer, The Baylor Company, Inc.
Houston, Texas

SEG Awards Thirteen Scholarships

SECOND annual award of university scholarships in geophysics has been made by the Society of Exploration Geophysicists, it was announced by Roy F. Bennett, foreign exploration manager of the Sohio Petroleum Company of Oklahoma City, and president of the society. Bennett said there will be 13 scholarships granted by individual companies interested in the geophysical profession, and one scholarship financed by the organization's general fund. The 1957-58 educational grants will total $12,125, and will be taken in nine universities.

"The SEG scholarship plan was originated in 1957," said Bennett, "for the purpose of promoting the science of geophysics through improving the training of geophysicists. We felt that the expansion of our educational program through establishing a foundation with broad purposes, would eventually provide for research grants, teaching fellowships and other aids to universities. This will offer a chance for cooperation in supporting basic research sorely needed in geophysics."

Companies Granting

Companies granting one or more full-year scholarships under the SEG plan are the Grant Body and Equipment Company of Tulsa, Mayhew Supply Company, Griffin Tank and Welding Service and Geophysical Service, Inc., all of Dallas; Texas Gulf Sulpher Company, Schlumberger Well Surveying Corporation, Herb J. Hawthorne, Inc., Vector Manufacturing Company, Southwestern Industrial Electronics Company, and Superior Oil Company, all of Houston; and the Southern Geophysical Company of Fort Worth. The SEG General Fund Scholarship is sponsored jointly by Exploration Consultants, Inc. of Tulsa, and Well Instrument Development Company and Exploration Sales Corporation, of Bellaire, Texas.

Colleges chosen by the students for their work in geophysics include California Institute of Technology, Georgia Institute of Technology, Colorado School of Mines, Michigan College of Mining and Technology, Texas A&M College, University of Tulsa, University of Wisconsin, Rice Institute, and the University of California at Los Angeles. Students winning the scholarships ranged from freshmen to graduate students, it was disclosed.

The SEG, with headquarters in Tulsa, Oklahoma, supervises the impartial selection of scholarship winners, based on their previous scholastic record and their desire to obtain the training needed for a career in exploration geophysics.

Scholarship Winners

Scholarships were awarded to Terrill E. Buffum, Robert J. Mathieson and Fred A. Schwab of Tulsa; Glenn A. Burdick, Pocatello, Idaho; Wendell E. Cloepfil Jr., Portland, Oregon; Stephen A. Finnegan, Dollar Bay, Michigan; Glenn A. Jones, Dallas; Robert F. Montgomery, Houston; Ramil C. Wright, New Orleans; Joe Parr III, San Antonio; Miss Judith Kay Powers, Kermit, Texas; James Simpson, McAllen, Texas; John S. Steinhart, Madison, Wisconsin; and Richard F. McReynolds, Brownfield, Texas.

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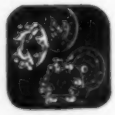

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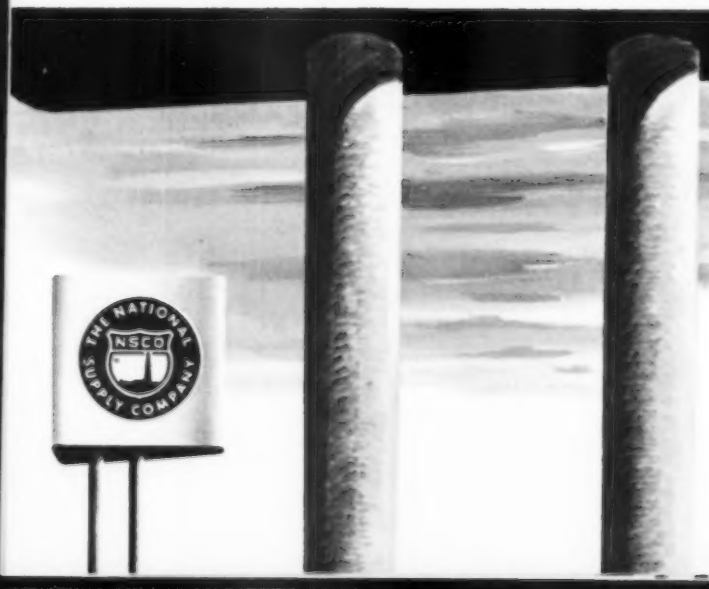

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(Continued on next page)

(*Continued from preceding page*)

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You can also get more useful product information at a National Store. Maintenance instructions, charts of equipment ratings and other helpful bulletins are available. You'll find technical descriptive bulletins on drilling and production equipment and accessories.

Finally, you can see for yourself *new* products and improvements in old ones when you stop at a National Store. This is a big advantage you gain by personally visiting the store. You get a first hand picture of what new equipment or methods may mean in improving your operations.

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Below, a Spang inspector uses a master gauge to check thread accuracy on Extreme Line Casing at National's Ambridge, Pa., plant —one of the nation's largest plants for the exclusive production of oil field tubular goods.

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Two major ingredients are responsible: The SPANG Extreme Line Casing Joint *and* the extremely accurate manufacturing processes used to produce this casing. The design of the joint means that it is easy to run and re-run repeatedly—it is 100% leak-resistant and has high joint strength—it is streamlined for maximum running efficiency and clearance—it has a minimum number of threaded connections.

The special steps taken to produce this casing mean it will give you the high quality performance required. From ingot steel to barge or gondola car, the making of Extreme Line casing is checked many times, many ways. Countless lab tests and many inspections (including the new Magnaglo process in grade P-110) are used to assure its high quality.

Remember these important ingredients when you consider the requirements for your next well. Talk it over with the people who have *specialized* in high quality oil field tubular goods for over 40 years—National Supply's SPANG Division and its representatives in your area.

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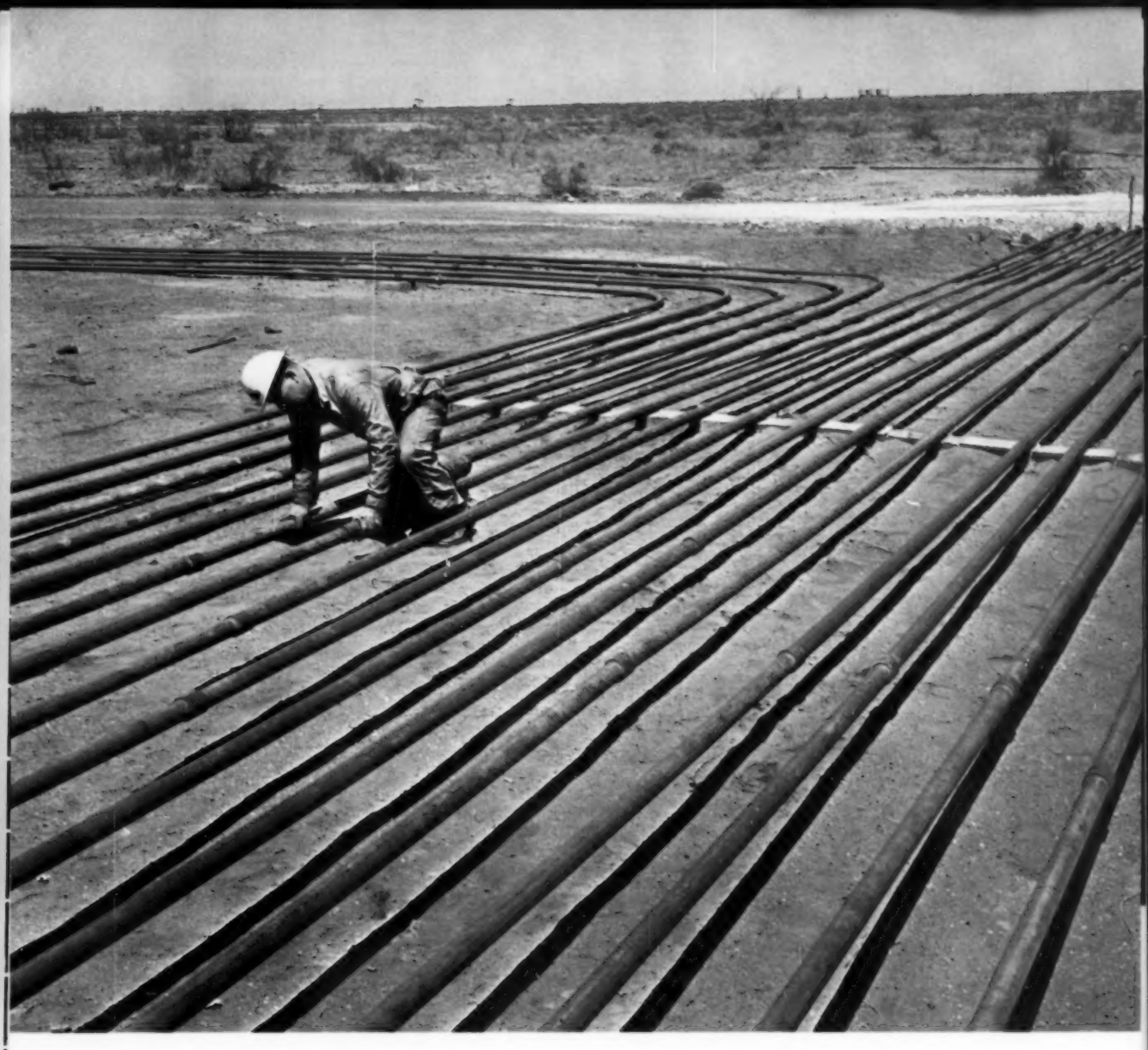

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NATIONAL BLUE OIL FIELD MACHINERY AND EQUIPMENT
SPANG STEEL PIPE AND ELECTRICAL CONDUIT

Charts speed . . .

Porosity Evaluation of Radiation Logs

Limestones are tricky; their porosity — not necessarily saturation — determine the commercial producers. These charts, developed in conjunction with a new model neutron/neutron logging tool, add to speed and accuracy of formation evaluation

OF POTENTIAL importance to many oil operators — especially those who have had the misfortune of setting pipe in a promising limestone only to find, after spending vast sums on an attempted completion, that the formation's porosity was too low to sustain commercial production — is a new radiation logging tool. Said to be more sensitive than its predecessor, the new instrument was dubbed the PH-125 by its developer, Perforating Guns Atlas Corporation of Houston, Texas. It is a new model of the company's neutron/neutron logging tool, and extensive tests indicate it to be less sensitive to error-inducing factors, such as chemical side effects, variation of hole size, and other radiations (gamma rays, etc.). Extensive laboratory and field tests have shown that if the instrument is carefully run, the resulting logs when properly interpreted will give a good indication of the porosity of these tricky limestone formations.

Accurate data on limestone porosity in West Texas, as well as other difficult areas where porosity values are hard to come by, means substantial savings in overall well costs.

The problem involving these limestones stems from the fact that the mere presence of oil or gas saturation does not tell the tale so far as a pos-

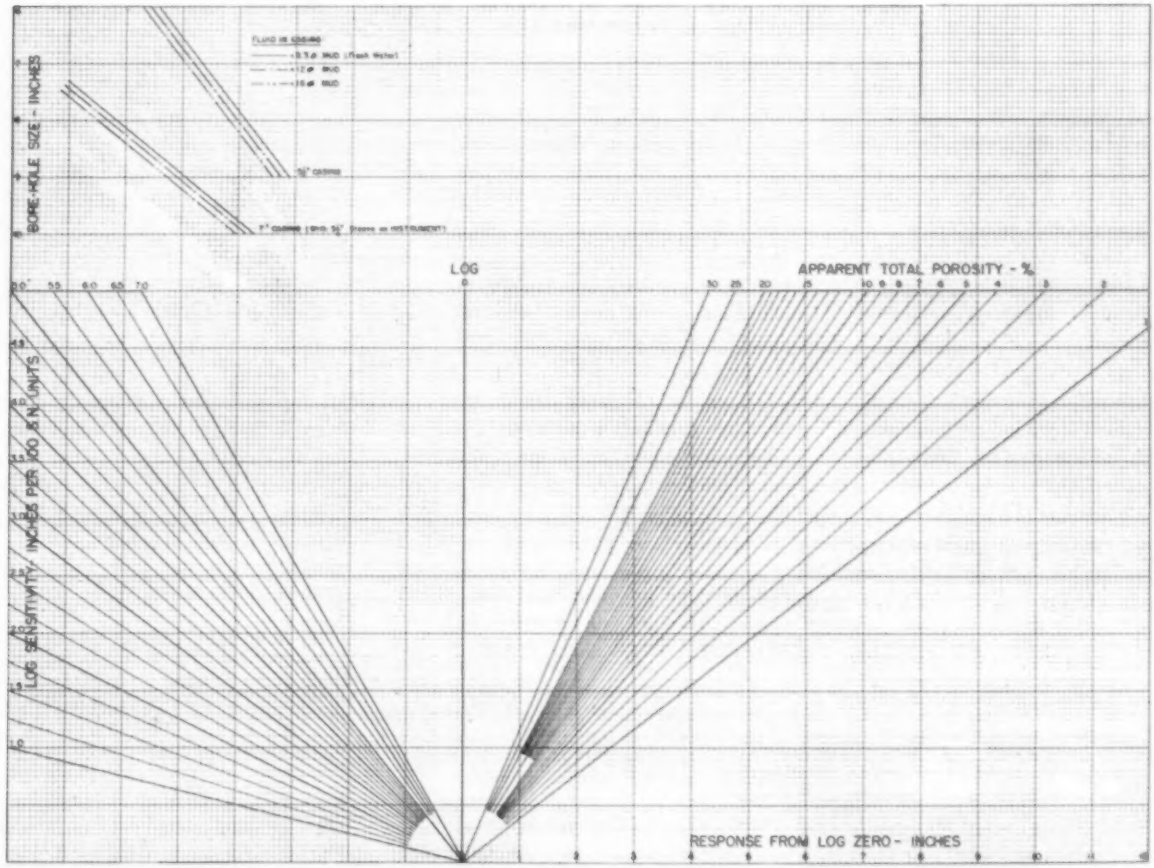
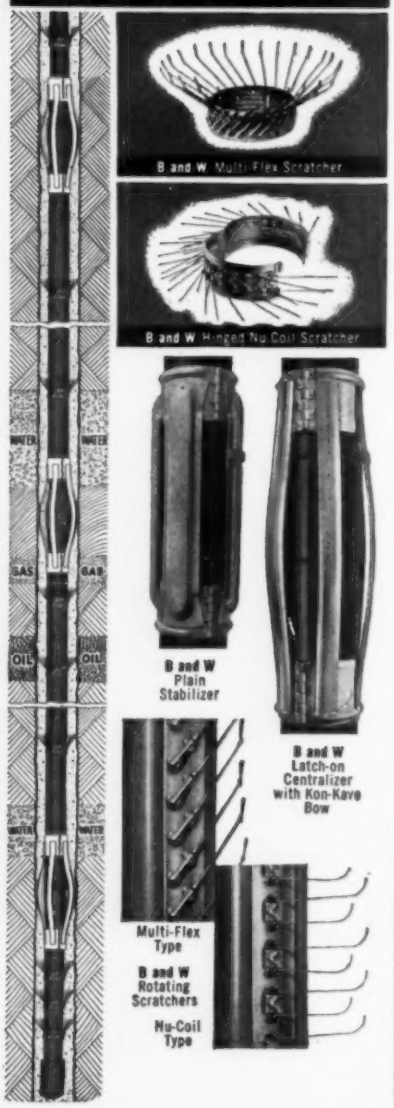

BORE-HOLE SIZE - INCHES
LOG
APPARENT TOTAL POROSITY - %
LOG SENSITIVITY - INCHES PER 100 S.N. UNITS
RESPONSE FROM LOG ZERO - INCHES

FIG. 1. **Working chart** to speed porosity evaluation of logs made by the new neutron/neutron instrument in cased, fluid filled bore holes and where the logging tool has been centralized. The curve for 7-in. casing was based on using a 5¼-in. sleeve on the instrument. This nomograph is not produced here to proper scale and should not be used for actual log interpretation.

B and W
SCRATCHERS AND CENTRALIZERS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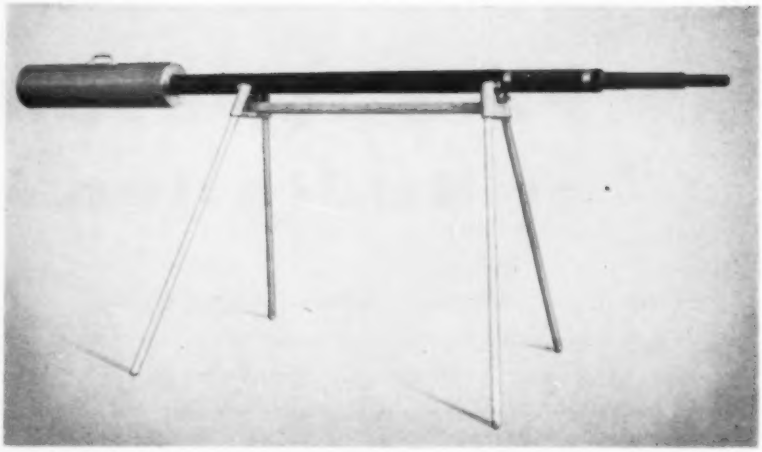

FIG. 2. **Logging instrument** on calibration stand. The calibrator is shown slipped over the neutron portion of the instrument.

sible oil or gas well is concerned. Porosity of the formation is a big factor. As one oil operator summed it up not long ago in describing the play in one of the Permian Basin trends, "It doesn't make much difference where you drill in this particular area, you are sure to cut several oil-saturated limestone formations. If porosity is high enough you have an oil well. Otherwise, you've got a very, very expensive dry hole because the only way you can test a hole is to set pipe on it."

Although this practice of setting pipe to test limestone formations is expensive, it is not nearly so costly as drilling a rich productive formation and **missing** it.

It's a matter of record that large oil and gas reserves have been drilled through — unknowingly! Many of these have since been discovered, but chances are there are hundreds of fields that have been drilled and not yet discovered.

Why? As the old drillers used to say, "It's dark below the rotary table," and to a degree this still holds true today. This is why any improvement in subsurface logging methods or equipment receives such a welcome from the industry.

Description of the instrument. Basically, the new tool is a simple instrument. It contains a pellet that emits some 10 million high-energy neutrons per second into the formation surrounding the instrument, and a detector that registers the number of neutrons of specific energy level that return to the instrument. Various elements react with the outgoing neutrons, but none more readily than hydrogen. By limiting the spectral response of the detector exclusively to epithermal energy neutrons, high sensitivity to environmental hydrogen is achieved, and the effect of thermal neutron reactive elements (salt, etc.) in the bore hole fluid is eliminated.

Summed up, the logging device is in reality a high caliber hydrogen detector, and this in itself minimizes the errors ordinarily attributed to down-the-hole factors that cannot be measured economically.

There are, however, factors which can produce erroneous readings, but these can be controlled through the technique employed in running the instrument and through knowledge of factors present in the hole when the readings are taken. For instance, knowing that the position of the instrument with respect to the center of the hole affects the readings, it is possible to positively position the instrument during the readings.

Calibration

For the laboratory tests, the logging instrument and associated equipment were calibrated in the same manner employed in regular field operations by using an environmental calibrating standard. This is done by placing the instrument horizontally on a special stand 4-ft from the ground, completely assembled and powered for operation. The environmental calibrator is then slipped into position over the neutron portion of the instrument; as shown in Fig. 2.

The calibrator consists of a cylindrical plastic tube, 36-in. long and 8½-in. OD, and fitted with internal positioning rings for holding it concentric with the instrument. All calibrators are adjusted to be equal to a primary standard kept in the laboratory. The neutron response created by the hydrogen in the calibrator, referred to as "calibration deflection," is recorded on each log chart with the assigned value of "100 Standard Neutron Units." In developing this calibration system, care-

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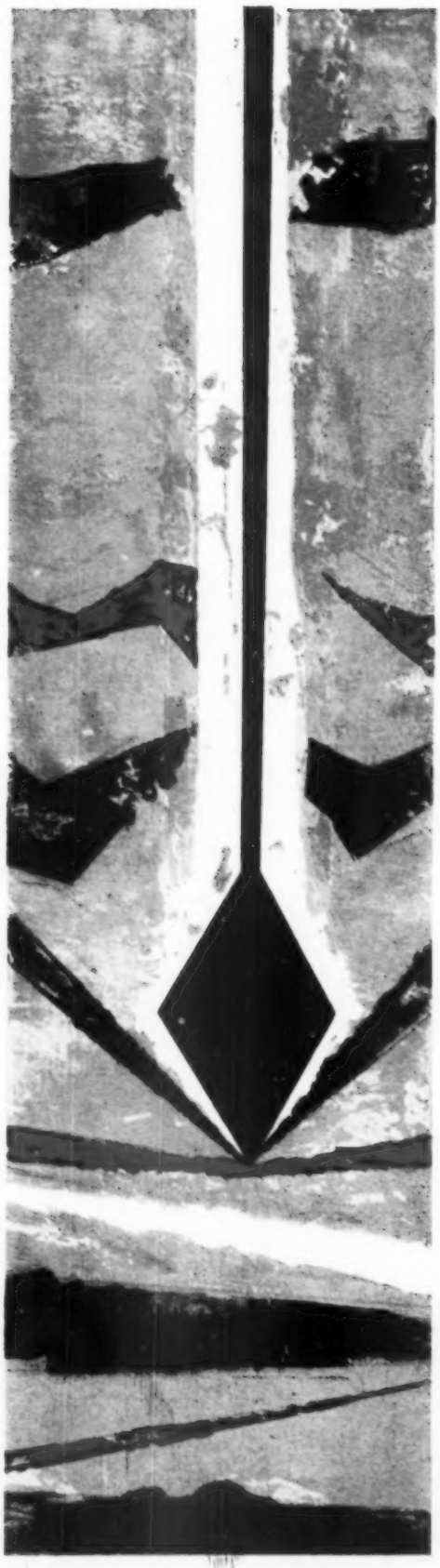

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ful attention was given to insuring that the proximity of the earth during calibration does not influence the measurements.

The calibrator is designed so that the response produced is of the same order of magnitude as that obtained with the logging instrument in average well conditions, an important factor in accurate porosity evaluation. Sensitivity of the logging system may be controlled at the surface to provide any calibration deflection desired. All charts described here are based on neutron response in terms of Standard Neutron Units and are applicable to field logs.

Laboratory calibration for limestones. Data for the accompanying chart were obtained by running neutron logs in laboratory artificial wells consisting of large limestone blocks with various bore hole sizes in which the casing and fluid conditions were varied. Three steel cased pits were filled with blocks of limestone representing three typical porosities. One pit contained three typical stones with a 6¼-in. hole; the second with a 7⅞-in. hole, and the third with an 8¾-in. hole. Fig. 3 illustrates the arrangement of the stones in the pits.

Careful attention was given to the

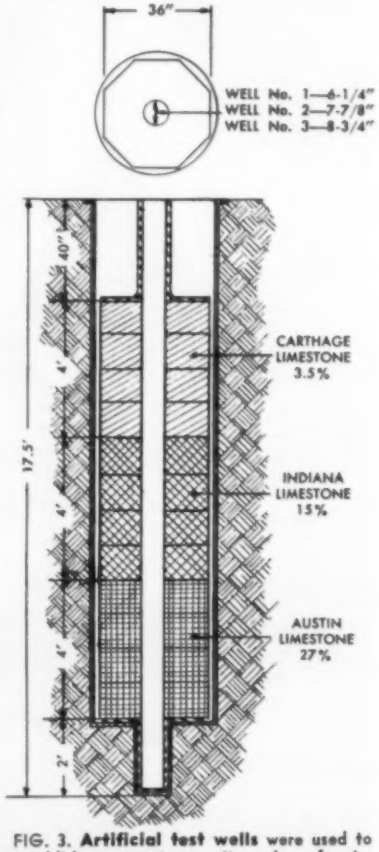


FIG. 3. **Artificial test wells** were used to establish apparent porosity values for instrument.

choice of materials to be used in representing actual formations. Since the primary objective of the tests was to relate neutron response with fluid filled porosity, first consideration was given in selecting materials available in porosities over the range of interest, with uniformly distributed pores, and absence of fractures. Secondly, the material was chosen to be clean and dimensionally stable. Careful consideration was also given to the exclusion of any chemical impurities peculiar to field conditions which might influence the neutron log. On the basis of these requirements, Carthage limestone was selected for the minimum porosity, Austin limestone for the highest porosity, and Indiana limestone for intermediate porosity.

The stones were machined into octagons measuring 36 in. across and 12 in. thick. They were lathe-bored for the hole sizes mentioned above.

The stones were then evacuated, filled with fresh water, and careful volumetric measurements were made

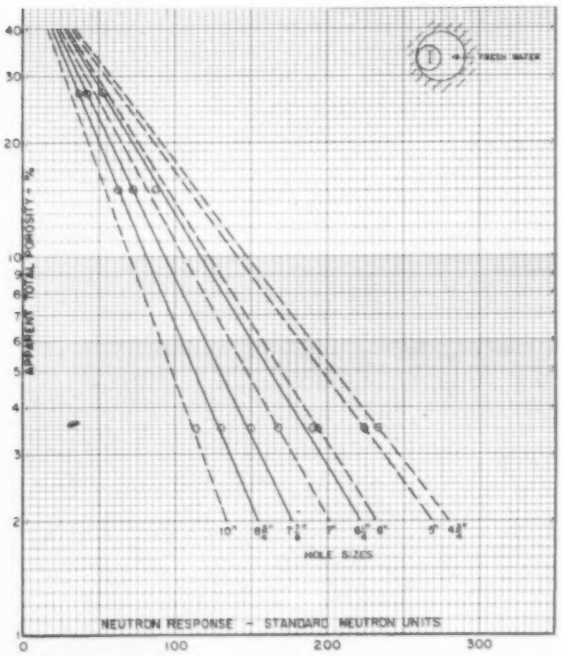


FIG. 4. **Response in uncased, water-filled bore holes** with instrument against one side of the wall.

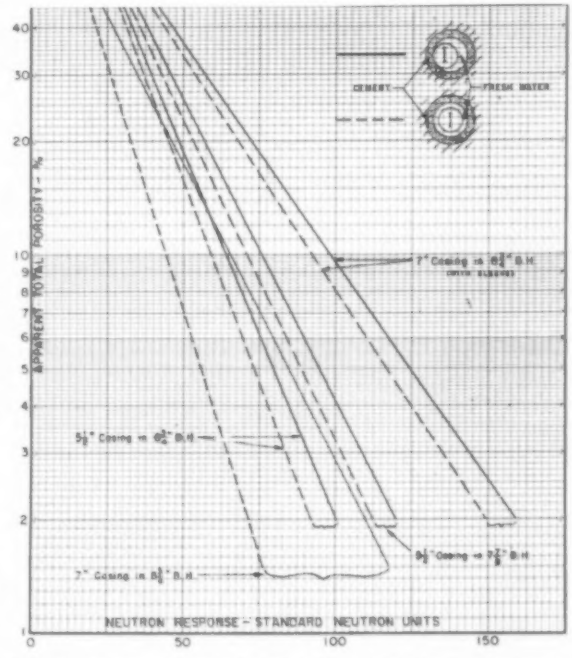


FIG. 5. **Response in cased, water-filled bore holes** with cement-filled annulus.

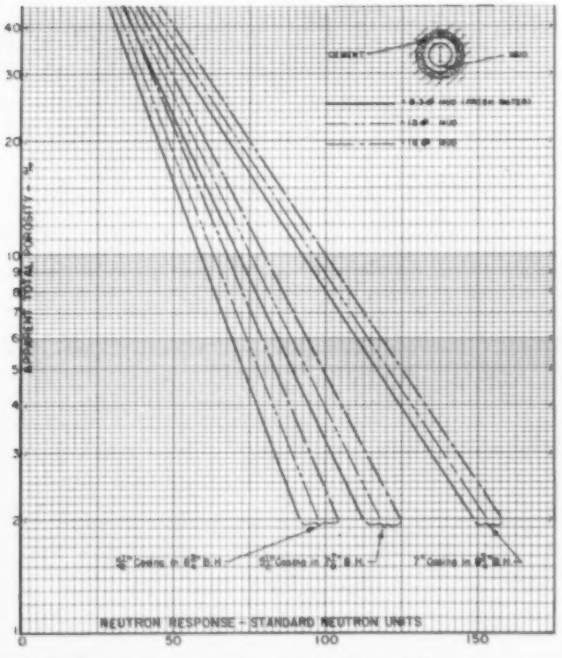


FIG. 6. **Response in cased, cemented bore holes** with various weight fluids — instrument centered.

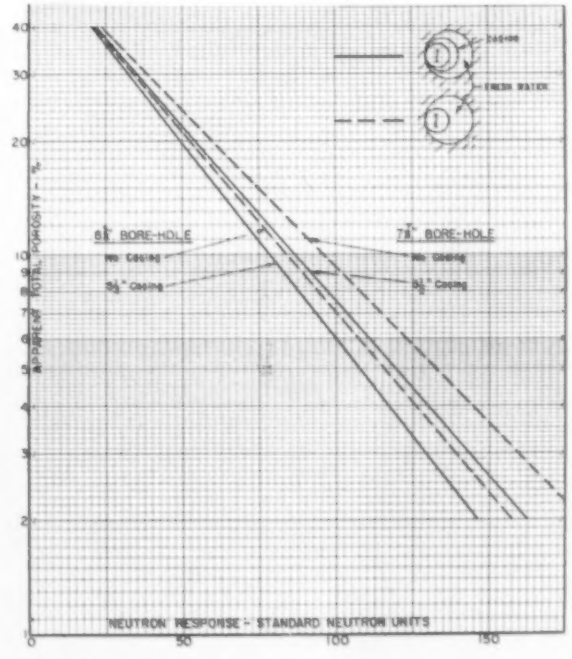
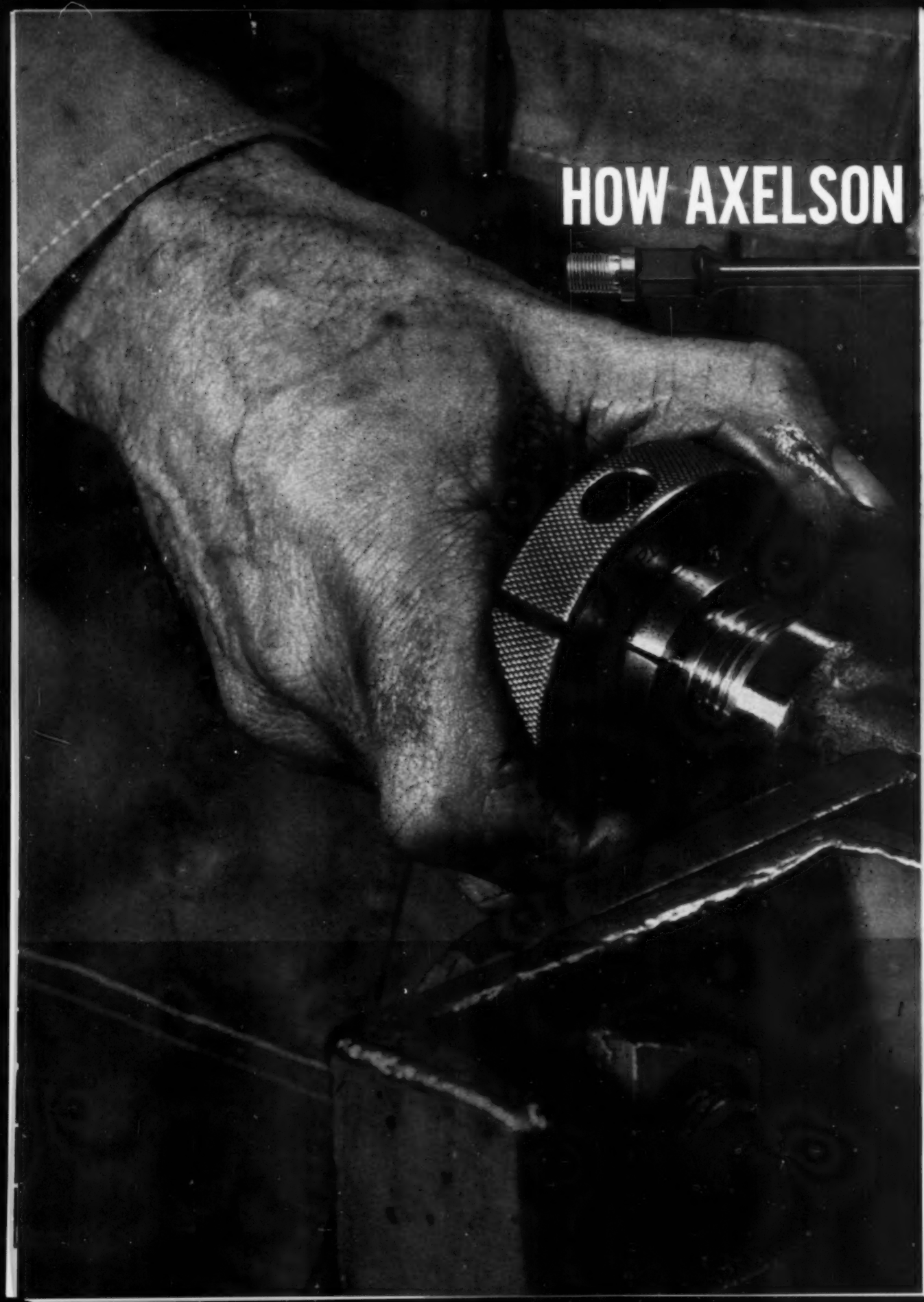


FIG. 7. **Effect of casing** on neutron response.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In 59 years of manufacturing equipment for the petroleum industry, AXELSON has pioneered many methods for putting more life in sucker rods:

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Every AXELSON sucker rod *is checked at both ends with three thread gages. Protective coating, coupling and cap are added immediately after inspection to protect threads and prevent rust or corrosion.*

The threads of AXELSON *Parkerized couplings undergo the same rigid inspection as rod pin threads. Accuracy of coupling and rod pin threads assures perfect alignment, tight joints with greatest bearing surfaces.*

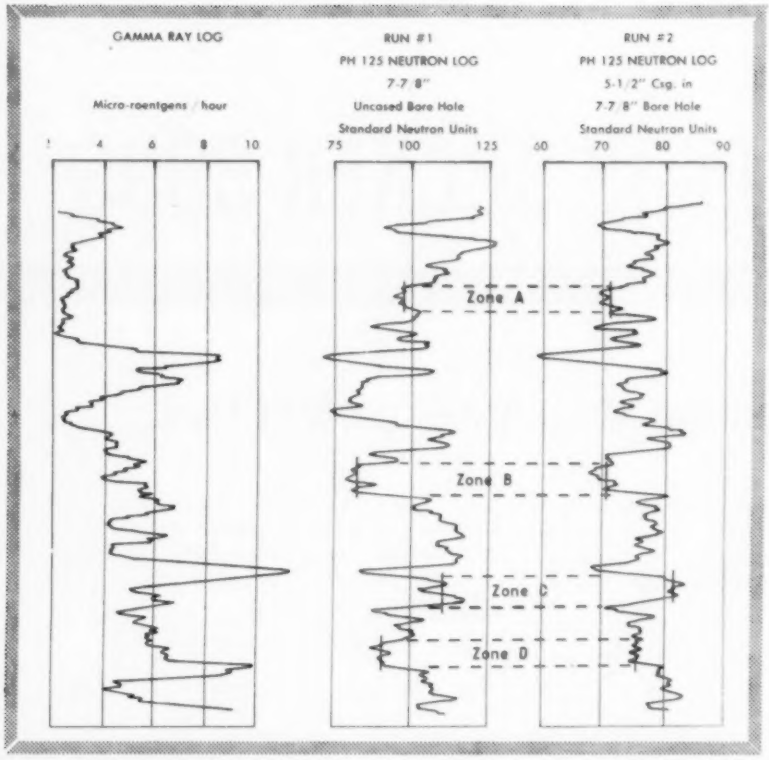


FIG. 8. **Field example** showing comparison of porosity evaluation made under two different bore hole conditions.

to arrive at the adjusted values of total porosity. Their total porosities were: Carthage limestone—3.5 percent; Indiana limestone — 15.0 percent; and Austin limestone — 27.0 percent.

These stones were placed in the artificial wells and logs were run. Initial tests were devoted to confirming correct alignment of the holes in a series of stones, and verifying that the stones represented infinite media. Logs were made with several instruments with repeatedly changed hole conditions for verifying adequacy of control for reproducible data. The results indicate that field conditions are very closely represented by the artificial wells and test facilities.

Results of the tests were plotted with values of "Apparent Total Porosity" (ATP) for the three limestones as ordinates on a logarithmic scale and corresponding instrument responses in Standard Neutron Units as abscissae on a linear scale. The curves were completed by interpolation between points, and by extrapolation above 27 percent and below 3.5 percent ATP.

The accompanying charts (Fig. 4, 5, 6 and 7), are reproductions of some of these curves, and from them the following conclusions are apparent:

1. The effect of bore hole diameter is very important, and must be accounted for by means of the charts in making valid interpretations.

2. The position of the logging instrument with respect to the wall of the bore hole has considerable influence on neutron response. In **uncased** holes, this factor generally may be disregarded, since field experiments indicate that the instrument normally tracks the side of the hole. In **cased** holes, this factor is important, being mainly dependent on the casing's position in the bore hole, and is effectively minimized by centralizing the instrument within the casing.

3. In holes with large diameter casing (7-in. or larger), the log exhibits superior qualities by use of a specially designed sleeve on the instrument for displacing interfering bore hole fluid.

4. In bore holes not containing liquid, the instrument exhibits higher responses, but still retains high sensitivity to formation porosities, and permits relatively accurate interpretations.

5. The effect of variations of mud density is small, and may be neglected. Correction curves are provided for this factor where their use may be desired for greater accuracy.

6. Chemical effects on the log are so small as to be negligible. This permits valid porosity determinations to be made in wells in which the bore hole or formations may contain salt or elements which are neutron reactive.

Field Example. Fig. 8 illustrates the results obtained in porosity evaluation of a well in West Texas (limestone formation) in which PH-125 neutron/neutron logs were made before and after setting casing. Good bulk core data were available in the four zones shown, and they correlate quite well with the values determined from the neutron logs.

The 7⅞-in. hole size curve from Fig. 4 was applied to the first log made in the uncased hole. The appropriate curve from Fig. 6 was applied to the four zones on the second log made in cased hole, and the results are shown in Table 1.

Validity of the evaluation charts is confirmed by the close agreement of values determined by the two neutron logs with each other and with the core.

The nomograph shown in Fig. 1 can be used for determining the porosity of formations logged by the instrument in cased hole.

To use this working chart, project horizontally from the proper hole size value at the upper left to the appropriate casing and mud weight curve; then downward to intersect the line representing the calibration deflection (sensitivity) used for recording the log. From this intersection point, draw a horizontal line to the right to cross the porosity fan scale. A straight edge of plain paper is then laid on the fan scale at this level, and log zero and porosity values transcribed. By transferring this paper to the log, the log deflections may be translated.

This nomograph (Fig. 1) is not reproduced to correct full scale, and therefore, should not be applied to actual logs for interpretation. Copies of the original full scale charts may be obtained from the originators of this new logging tool. ★ ★ ★

TABLE 1. Porosity Values Obtained in Four Zones of a West Texas Well Show Close Correlation.

ZONE	CORE ANALYSIS Porosity (Percent)	Run No. 1 N/N Log — UNCASED HOLE 7⅞-in. Diameter (Instrument free-hanging)	Run No. 2 N/N Log — CASED HOLE 5½-in. Csg. in 7⅞" B.H. (Instrument centralized)
A	9.5	10.0	10.0
B	12.9	13.0	11.0
C	7.0	7.6	6.8
D	9.6	11.0	8.5

SPE–AIME Discuss New Drilling Device and Miscible Displacement

A REPORT on Humble's high-speed low-torque drilling device, results of advanced studies of oil recovery by underground burning, and field and laboratory reports on the miscible displacement process are among the 75 technical papers to be presented at the thirty-second annual fall meeting of the Society of Petroleum Engineers of AIME.

The meeting is being held at the Statler Hilton, Baker, and Adolphus hotels in Dallas, October 6-9. Three concurrent technical sessions are held each day, one in each of the hotels. An attendance of over 3000 is expected.

Humble's Turbine Drill

The Humble high-speed low-torque drilling device is essentially a cutting wheel which is turned by a built-in turbine at high speed by the flow of drilling mud through the turbine. The cutting wheel or bit revolves 400 to 500 rpm with normal fluid circulation. After an early failure the tool has been redesigned, with diamonds being used as cutting elements in place of tungsten carbide inserts.

George E. Cannon, author of the paper, feels that the principal anticipated application of this tool is in hard formations which would normally have to be drilled with reduced bit weight due to hole deviation characteristics. Since the drill operates without the application of bit weight, this feature should provide a means for obtaining a straight hole through a normal crooked hole zone with increased bit life and drilling rate.

In-Situ Combustion

On the subject of in-situ combustion, papers will be presented by Continental Oil Company and Gulf Research and Development. The Continental paper by W. L. Martin, J. D. Alexander, and J. N. Dew, describes results and conclusions obtained from a series of exploratory in-situ combustion experiments. The mechanism of oil recovery by in-situ combustion will be discussed.

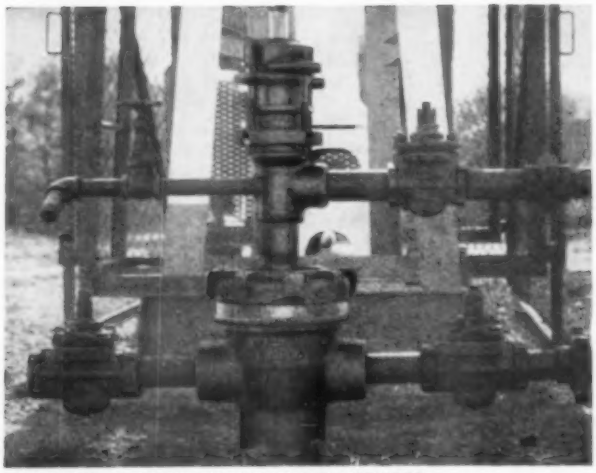
The Gulf paper presents a method of predicting the production history of an underground combustion recovery process. The authors will state that in recovery by in-situ combustion, three distinct zones exist ahead of the combustion zone; (1) a zone termed a water bank which contains three mobile phases — oil, gas, and water; (2) a region containing two mobile phases — oil and gas – called the oil bank, and (3) a zone having the fluid saturation distribution which existed prior to combustion. Authors of this paper are L. A. Wilson, R. J. Wygal, D. W. Reed, R. L. Gergins, and J. H. Henderson.

Miscible Displacement

A paper by C. L. Barney of Magnolia Petroleum Company presents a method for estimating recovery and performance under a program of high-pressure gas injection in volatile oil reservoirs under vaporization conditions.

"Secondary Recovery by Butane Injection in San Pedro Block D" is a paper describing the secondary recovery project involving butane injection followed by injected gas. The program has been in operation for six years and data will be presented covering both primary and secondary phases of depletion. The author, Robert Moscrip III, International Petroleum Company, Ltd., Talara, Peru, states that field tests indicate substantial increases in oil recovery and that essentially all of the injected butane can be recovered wth the produced fluids.

What the WELL-DRESSED, MEDIUM-PRESSURE Wells are wearing



This well is equipped with the compact "Tee Base Type" HERCULES Duplex Stuffing Box and HERCULES "Type SO" Tubing Head. The Tubing Head is equipped with HERCULES original overhead packing arrangement and self-aligning hinged slips, making this a simple yet complete hook-up, featuring safety with simplicity and minimum of parts.

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Use of Cellulose Derivatives In . . .

Salt-Contaminated Drilling Muds

Low viscosity sodium cellulose sulfate and commercial grade CMC reduce viscosity and improve filter properties of salt-contaminated muds previously treated with quebracho

W. Hodge Caraway
U. S. Bureau of Mines,
San Francisco, California

IN A RECENT study[1] of domestic substitutes for quebracho for controlling the viscosity and filter properties of drilling muds, low-viscosity sodium cellulose sulfate was found to be unsuitable as a quebracho substitute, but was very effective in reducing the viscosity and improving the filter properties of salt-contaminated drilling muds previously treated with quebracho. Further studies of the effect of sodium cellulose sulfate on the properties of salt-contaminated muds confirmed the earlier findings. Similar tests showed that a commercial-grade low-viscosity carboxymethyl cellulose (CMC) also would reduce the viscosity of salt-contaminated drilling fluids previously treated with quebracho.

Sodium cellulose sulfate (sodium salt of cellulose acid sulfate) is a light tan, dense, free-flowing powder soluble in both hot and cold water. It is nontoxic and is stable at high temperatures and in alkaline and in salt solutions. At room temperature, a 10 percent sodium cellulose sulfate solution remained virtually free of bacterial growth for approximately a month. Production of this material has been limited to small quantities in a pilot plant operation, although commercial production may be assumed if the demand warrants it. The material was produced in both low-viscosity and medium viscosity grades.

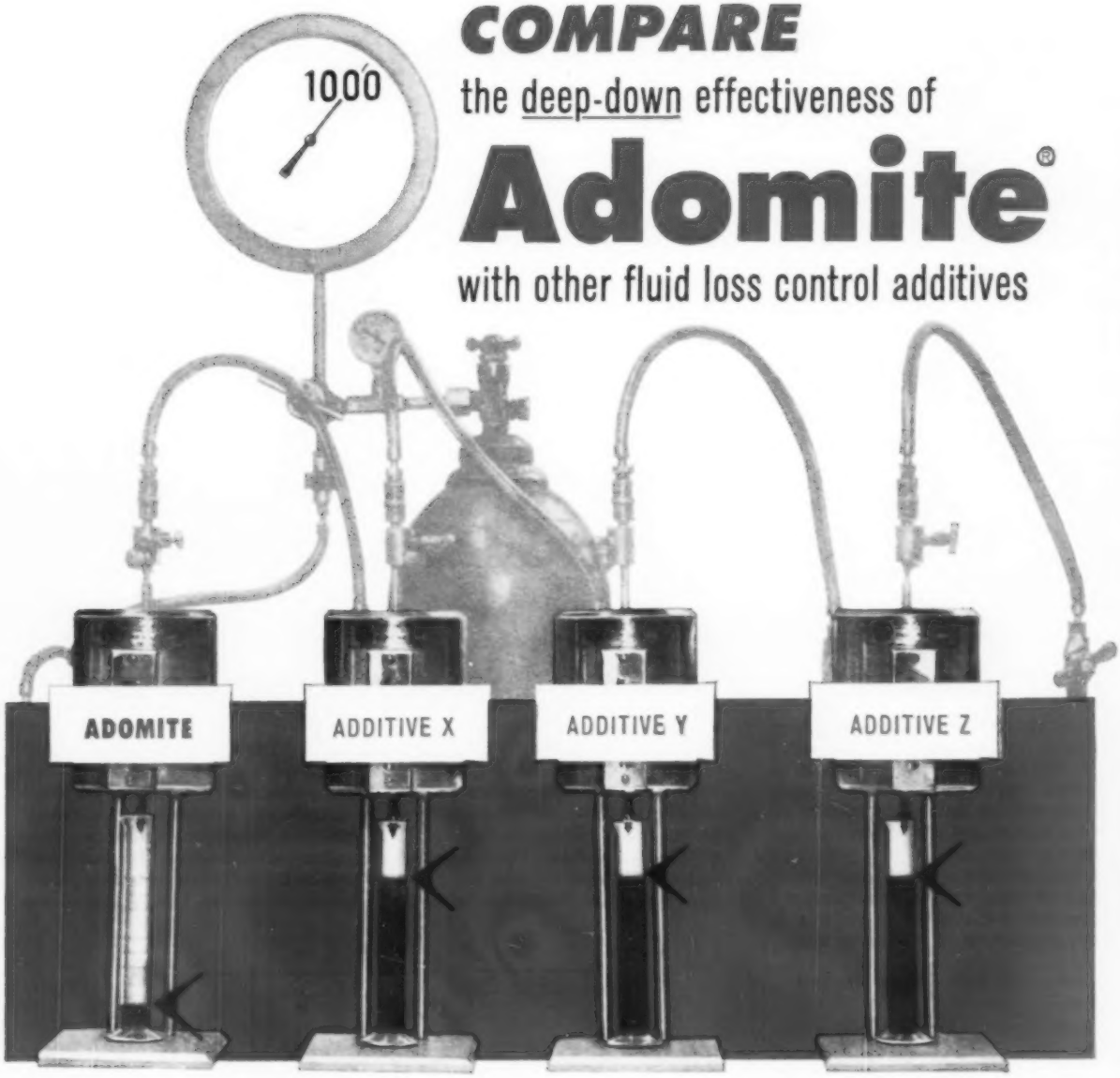
Two grades of carboxymethyl cellulose were evaluated in preliminary tests. One was designated as a low-viscosity grade by the manufacturer. The second is a commercial grade sold to

COMPARE

the deep-down effectiveness of

Adomite®

with other fluid loss control additives



Just how effective is your present fluid loss control additive at bottom hole conditions? As you undoubtedly know, many fracturing additives show desired fluid loss control at surface conditions of low pressure and room temperature. But at bottom hole conditions, fluid loss becomes so high that their effectiveness is lost. Compare them with Adomite. Tests show that, *deep down*, nothing safeguards your profits like Adomite.

What makes the difference?

Adomite, when mixed with oil, disintegrates into millions of tiny particles. These particles seal the face of the formation and keep the fracturing fluid from filtering in. Temporarily sealing the formation, Adomite particles do not plug it.

Other additives, too, contain sealing particles, but these tend to soften or dissolve as temperatures increase. Result: fluid loss control is greatly reduced.

	Fluid Loss at Surface Conditions— 100 psi,* 75°F., cc/30 min.	Fluid Loss at Bottom Hole Conditions— 1000 psi, 150°F., cc/30 min.
ADOMITE + crude oil	2.2	22.0
Additive X + crude oil	37.8	Infinite
Additive Y + crude oil	8.5	Infinite
Additive Z + crude oil	13.0	295 (1 min., 50 sec.)

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(*Standard API Code 29 Test)

To get best results downhole with straight crude, gelled crude or refined oil, always *specify* Adomite.

FRACTURE WITH ADOMITE

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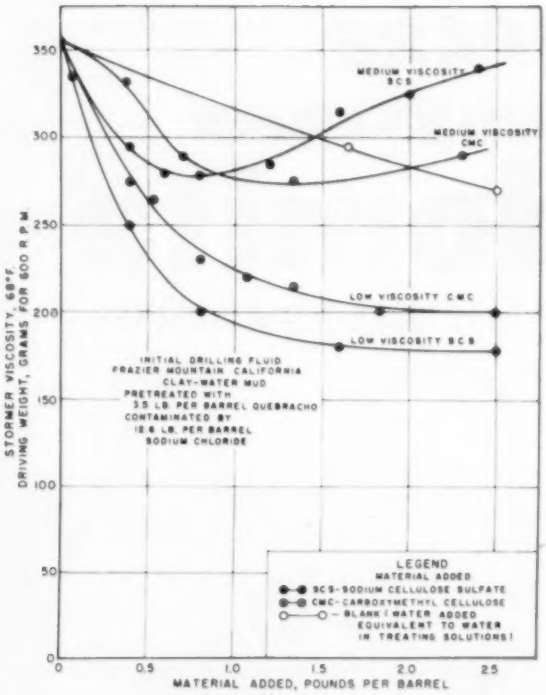
MEDIUM VISCOSITY SCS
MEDIUM VISCOSITY CMC
LOW VISCOSITY CMC
LOW VISCOSITY SCS
INITIAL DRILLING FLUID FRAZIER MOUNTAIN CALIFORNIA CLAY-WATER MUD PRETREATED WITH 3.5 LB. PER BARREL QUEBRACHO CONTAMINATED BY 12.6 LB. PER BARREL SODIUM CHLORIDE
LEGEND
MATERIAL ADDED
SCS-SODIUM CELLULOSE SULFATE
CMC-CARBOXYMETHYL CELLULOSE
BLANK (WATER ADDED EQUIVALENT TO WATER IN TREATING SOLUTIONS)
STORMER VISCOSITY, 68°F. DRIVING WEIGHT, GRAMS FOR 600 R P M
MATERIAL ADDED, POUNDS PER BARREL

FIG. 1. **Effect of different cellulose derivatives** on the viscosity of a salt-contaminated California-clay mud.

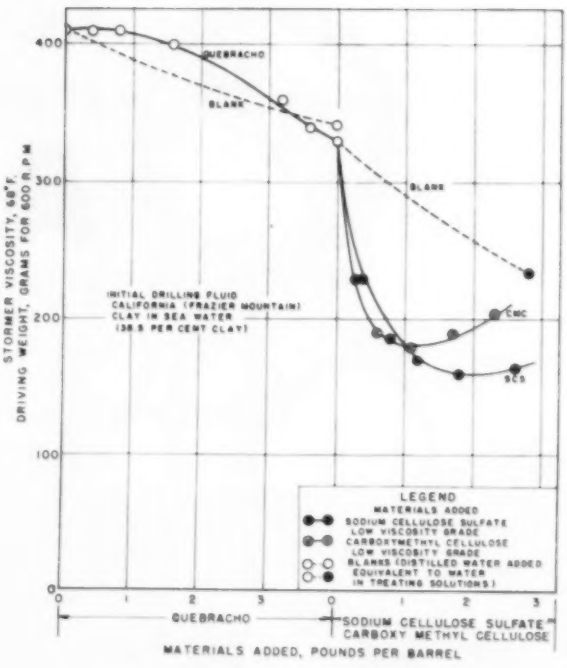
QUEBRACHO
BLANK
BLANK
CMC
SCS
INITIAL DRILLING FLUID CALIFORNIA (FRAZIER MOUNTAIN) CLAY IN SEA WATER (30.5 PER CENT CLAY)
LEGEND
MATERIALS ADDED
SODIUM CELLULOSE SULFATE LOW VISCOSITY GRADE
CARBOXYMETHYL CELLULOSE LOW VISCOSITY GRADE
BLANKS (DISTILLED WATER ADDED EQUIVALENT TO WATER IN TREATING SOLUTIONS)
QUEBRACHO
SODIUM CELLULOSE SULFATE CARBOXY METHYL CELLULOSE
STORMER VISCOSITY, 68°F. DRIVING WEIGHT, GRAMS FOR 600 R P M
MATERIALS ADDED, POUNDS PER BARREL

FIG. 2. **Effect of quebracho and low-viscosity cellulose** derivatives on the viscosity of a California-clay-sea-water mud.

the drilling industry. This material formed suspensions with a viscosity comparable to that of suspensions of the manufacturer's medium-viscosity grade.

For maximum utility of the information, the results are summarized and presented in several graphs and a table with a minimum of descriptive text.

Control of Salt-Contaminated Mud

Salt contamination of fresh-water-base drilling mud during the course of drilling a well often presents a severe problem in controlling the mud properties. As the salt content increases either from salt water or crystalline salt from the formations penetrated, mud viscosity and filtrate volume increase rapidly.

Preventive measures may be employed to minimize the effects of salt contamination, but improper handling of contaminated mud may lead to serious difficulties, such as a blowout or stuck drill pipe.

Salt-water entry into a well being drilled frequently can be controlled by increasing the mud weight. However, if salt water enters the drilling mud, the increase in viscosity and filtrate loss can generally be counteracted by adding quebracho and caustic to restore the original viscosity and filter properties. If salt continues to enter the drilling mud and treatment with quebracho is repeated, a condition frequently is reached when the addition of quebracho no longer effectively reduces the viscosity of the mud. Then, the mud engineer is confronted with the necessity of converting the system to an expensive lime-base mud or salt-water mud using special clays and gel-forming materials such as starch or carboxymethyl cellulose to improve the filter properties of the mud. The additional cost is for materials and rig time required for mixing and changing the

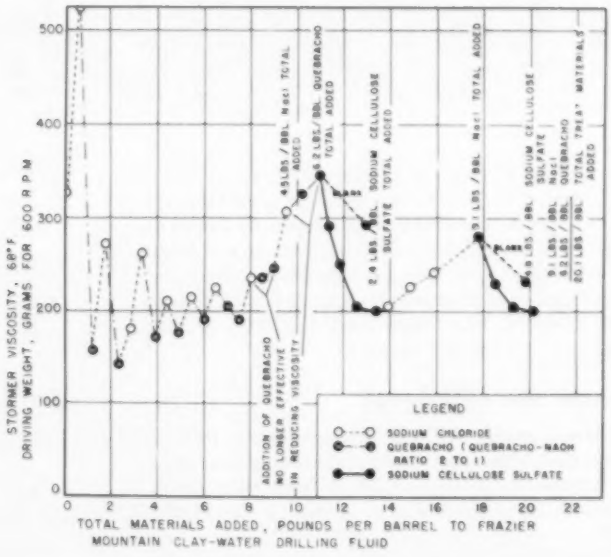
ADDITION OF QUEBRACHO NO LONGER EFFECTIVE IN REDUCING VISCOSITY
LEGEND
SODIUM CHLORIDE
QUEBRACHO (QUEBRACHO-NAOH RATIO 2 TO 1)
SODIUM CELLULOSE SULFATE
STORMER VISCOSITY, 68°F. DRIVING WEIGHT, GRAMS FOR 600 R P M
TOTAL MATERIALS ADDED, POUNDS PER BARREL TO FRAZIER MOUNTAIN CLAY-WATER DRILLING FLUID

FIG. 3. **Effect of quebracho and sodium cellulose sulfate** on the viscosity of a salt-contaminated California-clay mud.

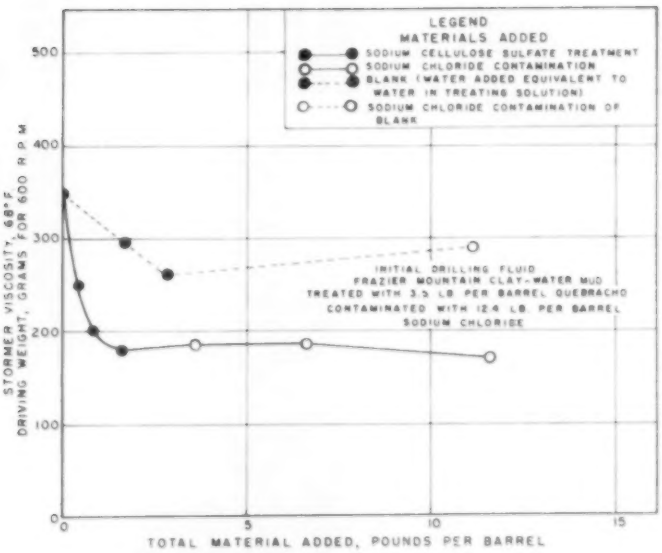
LEGEND
MATERIALS ADDED
SODIUM CELLULOSE SULFATE TREATMENT
SODIUM CHLORIDE CONTAMINATION
BLANK (WATER ADDED EQUIVALENT TO WATER IN TREATING SOLUTION)
SODIUM CHLORIDE CONTAMINATION OF BLANK
INITIAL DRILLING FLUID
FRAZIER MOUNTAIN CLAY-WATER MUD
TREATED WITH 3.5 LB. PER BARREL QUEBRACHO
CONTAMINATED WITH 12.4 LB. PER BARREL
SODIUM CHLORIDE
STORMER VISCOSITY, 68°F
DRIVING WEIGHT, GRAMS FOR 600 R.P.M.
TOTAL MATERIAL ADDED, POUNDS PER BARREL

FIG. 4. **Effect of additional salt contamination** on the viscosity of a California-clay mud treated with sodium cellulose sulfate.

mud. In this study a series of tests was run to show the effectiveness of low-viscosity sodium cellulose sulfate and carboxymethyl cellulose in controlling the viscosity of salt-contaminated drilling muds when quebracho treatment was no longer effective.

Use of salt water muds. The use of salt-water muds has been stimulated by the increase in offshore drilling in California and the Texas-Louisiana Gulf Coast. Interest in the use of drilling fluids containing salt will be increased with recognition of the importance of salt in minimizing the hydration of clays present in many petroleum-bearing rocks. In 1945, Johnston and Beeson[2] showed that about 70 percent of the California sands examined were subject to distinct and serious damage to permeability by the influx of fresh water. The Bureau of Mines is studying the clay-mineral content of petroleum-reservoir rocks and the effect of waters of various salinities on the permeabilities of the clay-bearing rocks. The first of a series of reports on these studies[3] show that permeabilities of three Wyoming reservoir sands are damaged less by salt water than by fresh water. As the use of salt water in drilling fluids receives more attention and general use, practical means of controlling this type of drilling mud will become more important.

How Tests Were Made

Four drilling muds were used in testing these materials. One of the muds was prepared from a California (Frazier Mountain) clay and fresh water, and the second was a hole mud from a well in the Gulf Coast near Alvin, Texas. The third drilling mud was a Frazier Mountain clay-fresh water mud that was converted to a high-pH, lime-base mud. The fourth was a suspension of Frazier Mountain clay in sea water.

Drilling muds containing Frazier Mountain clay have been found to be similar to untreated hole muds from California wells. Therefore, Frazier Mountain clay-water muds were used in these tests as typical of a California untreated hole mud. Densities of the fresh-water muds were about 74.8 lb per cu ft (10 lb per gal), and the density of the salt-water mud was about 82.3 lb per cu ft (11 lb per gal).

Effect on viscosity. Fig. 1 shows the effect of low and medium-viscosity grades sodium cellulose sulfate and carboxymethyl cellulose on the viscosity of a quebracho-treated, salt-contaminated California clay mud. Medium viscosity grades were ineffective, whereas the low-viscosity sodium cellulose sulfate and carboxymethyl cellulose reduced the viscosity of the mud from 350 grams to 180 and 200 grams

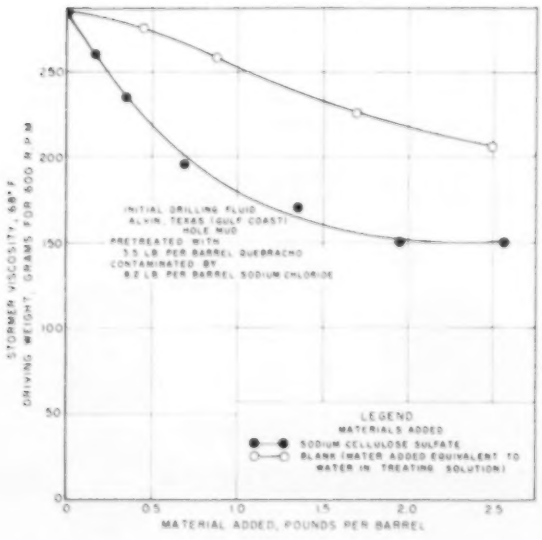

FIG. 5. **Effect of sodium cellulose sulfate** on the viscosity of a salt-contaminated drilling mud from the Texas Gulf Coast.

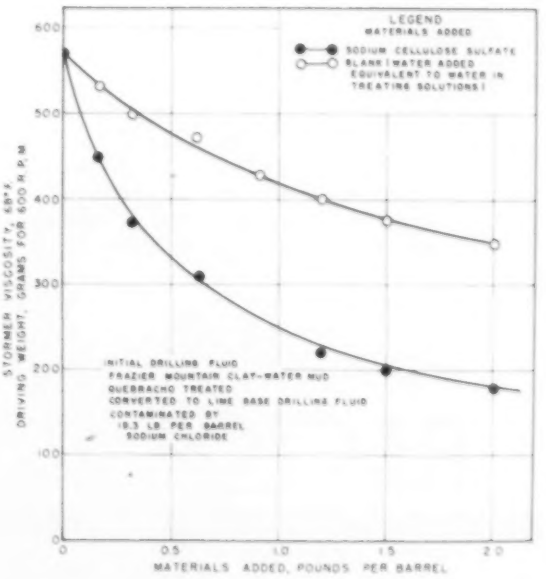

FIG. 6. **Effect of sodium cellulose sulfate** on the viscosity of a salt-contaminated lime-base drilling mud.

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Stormer driving weight[4] (600 rpm), respectively. Since the medium-viscosity grades were ineffective in this test, further tests were confined to the low-viscosity grades sodium cellulose sulfate and carboxymethyl cellulose.

Fig. 2 shows the effect of low-viscosity sodium cellulose sulfate and carboxymethyl cellulose on the viscosity of a mud prepared from a California clay and sea water and treated with quebracho. The sodium cellulose sulfate and carboxymethyl cellulose reduced the viscosity from about 330 grams to 180 and 160 grams Stormer driving weight (600 rpm), respectively, although quebracho treatment was ineffective. The addition of a low-viscosity carboxymethyl cellulose beyond a certain amount caused an appreciable rise in the viscosity, indicating a tendency toward overtreatment.

Since ample data are available on carboxymethyl cellulose and sodium cellulose sulfate is comparatively unknown, further tests were confined to the low-viscosity sodium cellulose sulfate.

Fig. 3 shows that the viscosity of the California-clay mud contaminated with 4.5 lb of sodium chloride per bbl of mud was no longer treatable with quebracho. However, addition of 2.4 lb of low-viscosity sodium cellulose sulfate per bbl of mud reduced the viscosity of the mud from 340 to 200 grams Stormer driving weight. The increase in viscosity resulting from further addition of 4.6 lb of sodium chloride per bbl of mud was counteracted by the addition of 2.4 lb of sodium cellulose sulfate per bbl of mud.

Fig. 4 shows the effect of additional salt contamination after sodium cellulose sulfate treatment of a quebracho-treated, salt-contaminated California clay mud. The mud was treated with 3.5 lb of quebracho per bbl, and 12.4 lb of sodium chloride per bbl of mud was then added. The viscosity of this mud was lowered from 350 grams to 180 grams Stormer driving weight by the addition of 1.6 lb of low-viscosity sodium cellulose sulfate per bbl of mud. The further addition of 10 lb of sodium chloride per bbl did not cause an increase in the viscosity of the mud. The resultant mud contained 22.4 lb of sodium chloride per bbl, but the viscosity was not excessive.

Fig. 5 shows that the viscosity of the Texas Gulf Coast hole mud that had been treated with quebracho and contaminated with 8.2 lb of sodium chloride per bbl was reduced from 300 to 150 grams Stormer driving weight by the addition of about 2 lb of low-viscosity sodium cellulose sulfate per bbl of mud.

A California-clay mud was converted to a high-pH lime-base mud, and

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B-109

TABLE 1. Effect of Cellulose Derivatives on the Filter Properties of a Quebracho-Treated Salt-Contaminated Drilling Mud.

Drilling mud	Quebracho pretreatment lb per bbl	Sodium chloride contamination after pretreatment, lb per bbl	Treatment after NaCl contamination SCS[1]	CMC[2]	API filter test ml, 30 min. Room temp	200 F
California	3.5	12.6	—	—	26.0	—
(Frazier	3.5	12.6	2.5	—	16.5	—
Mountain)	3.5	12.6	—	2.5	6.6	—
Clay-fresh	3.5	12.6	—	—	—	45.0
water	3.5	12.6	2.5	—	—	20.2
	3.5	12.6	—	2.5	—	17.6

[1]SCS is sodium cellulose sulfate, low-viscosity grade.
[2]CMC is carboxymethyl cellulose, low-viscosity grade.

19.3 lb of sodium chloride per bbl of mud was added. As shown in Fig. 6, the addition of low-viscosity sodium cellulose sulfate reduced the viscosity from 570 to 180 grams Stormer driving weight.

Effect on filtrate properties. The effect of the addition of low-viscosity sodium cellulose sulfate and carboxymethyl cellulose on the filter properties of a California-clay mud previously treated with quebracho and contaminated with sodium chloride is shown in Table 1. The filter properties were determined in the American Petroleum Institute filter press. The filtrate volume was the volume of filtrate obtained from the mud in 30 minutes under a pressure of 100 psi. The API filter press and the procedure is described in API RP 29.[5]

The standard API filtrate at room temperature from the California clay mud treated with quebracho and contaminated by sodium chloride was reduced from 24 ml to 16.5 ml by the addition of 2.5 lb of low-viscosity sodium cellulose sulfate per bbl of mud and from 24 ml to 6.6 ml by the addition of 2.5 lb of low-viscosity carboxymethyl cellulose per bbl of mud. However, the standard API filtrate of the same drilling mud at 200 F was reduced from 45 ml to 20.2 ml by the addition of 2.5 lb of low-viscosity sodium cellulose sulfate per bbl of mud, and from 45 ml to 17.6 ml by the addition of 2.5 lb of low-viscosity carboxymethyl cellulose per bbl of mud. Thus, the filter properties were improved considerably, particularly at higher temperatures. At 200 F the low-viscosity sodium cellulose sulfate and carboxymethyl cellulose reduced the standard API (30 minutes) filtrate volume from 45 ml to approximately 20 ml.

Effect of quebracho. The viscosity of a California clay-sea-water mud was reduced by both low-viscosity sodium cellulose sulfate and carboxymethyl cellulose treatment without the use of quebracho. However, quebracho greatly reduced the amount of sodium cellulose sulfate and carboxymethyl cellulose required, and also improved the filter properties considerably. The standard API filtrate volume at 200 F for treatment with 2.5 lb of carboxymethyl cellulose per bbl of mud was 50 ml without any quebracho, and 20 ml with 4 lb per bbl quebracho pretreatment. Treatment with 2.5 lb of sodium cellulose sulfate per bbl of mud reduced the filtrate volume to 55 ml without quebracho and 30 ml with the quebracho pretreatment.

The California clay-sea-water mud contained roughly the same amount of salt that was added to the California clay-fresh-water mud as contamination. When treated with quebracho and low-viscosity carboxymethyl cellulose, both muds had approximately the same viscosity and filter properties. Properties of both the treated muds were such that they would be satisfactory for use under most conditions.

The effect of sodium cellulose sulfate on the viscosity of a salt-contaminated California clay-fresh water mud not treated with quebracho also was determined. The addition of sodium cellulose sulfate to this mud caused no significant change in viscosity. Experiments with muds contaminated by different quantities of salt indicate that sodium cellulose sulfate causes an appreciable reduction in viscosity only after considerable contamination by sodium chloride. The material is best used with quebracho, probably because quebracho treatment is necessary to control the viscosity of the mud (see Fig. 3) until the salt-contamination range is reached where sodium cellulose sulfate treatment is effective. The reason why sodium cellulose sulfate treatment is more effective when the drilling mud is contaminated by salt is not understood, and additional work should be done on this problem.

Muds treated with phosphates. Complex phosphates are often used to control the filter properties and viscosity of drilling muds. Accordingly, a test was run to determine the effect of sodium cellulose sulfate on a salt-contaminated California-clay mud that had been treated with sodium acid pyrophosphate. Three pounds of sodium chloride were added per barrel of mud. After 1.5 lb of sodium acid pyrophosphate had been added, a total of 2.5 lb of sodium cellulose sulfate was added, and the viscosity decreased a small amount.

Results of these tests show that the low-viscosity sodium cellulose sulfate and carboxymethyl cellulose reduced the viscosity and the standard API filtrate volume of the quebracho treated salt-contaminated drilling muds used in these tests. Treatment with these materials was effective when quebracho treatment no longer reduced the viscosity of the salt-contaminated muds.

These materials were also effective in reducing the viscosity of a California clay-sea-water mud. Treatment after quebracho pretreatment greatly reduced the standard API filtrate volume from this drilling mud.

Acknowledgments

The author is indebted to the Tennessee Eastman Corporation (Wilson Meyer Company, Pacific Coast representative) and the Hercules Powder Company for supplying samples and helpful information regarding materials used in this investigation.

Grateful acknowledgment is made to R. J. White of the Baroid Division, National Lead Company, C. C. Wright of Oilwell Research, Incorporated, D. E. Silcox, W. W. McCabe, and B. McLaren of Standard Oil of California for reviewing the manuscript and making many helpful suggestions.

References

1. Caraway, W. Hodge, "Domestic Substitutes for Quebracho in Oil-Well Drilling Fluids," *The Pet Eng*, Vol. 25, No. 12, November 1953, pp. B81-B83, B86, B88, B89, B92.
2. Johnston, N., and Beeson, C. M., "Water Permeability of Reservoir Sands," AIME Vol. 160, 1945, pp. 43-55.
3. Baptist, O. C., and Sweeney, S. A., "Effect of Clays on the Permeability of Reservoir Sands to Various Saline Waters, Wyoming," Report of Investigations 5180, December 1955.
4. The viscosity of the drilling muds was measured in a Stormer rotating-cylinder viscosimeter. The results were expressed as grams driving weight required to rotate the cylinder at a rate of 600 rpm.
5. API RP 29, Recommended Practice for Standard Field Procedure for Testing Drilling Fluids, Third Edition, May 1950.

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EXPERIMENTS IN CONFINED TARGETS SUBSTANTIATE THE EVIDENCE. Tests were also made in 14" Berea Sandstone cores encased in 4½" drill pipe. A single shot—bullet or shaped-charge—was fired through a steel plate into the core. Two out of three bullets produced fractures to the end of the core. None of the shaped charges developed fractures.

Motion pictures were taken of the tests which give graphic proof of the results. You may see the film upon request.

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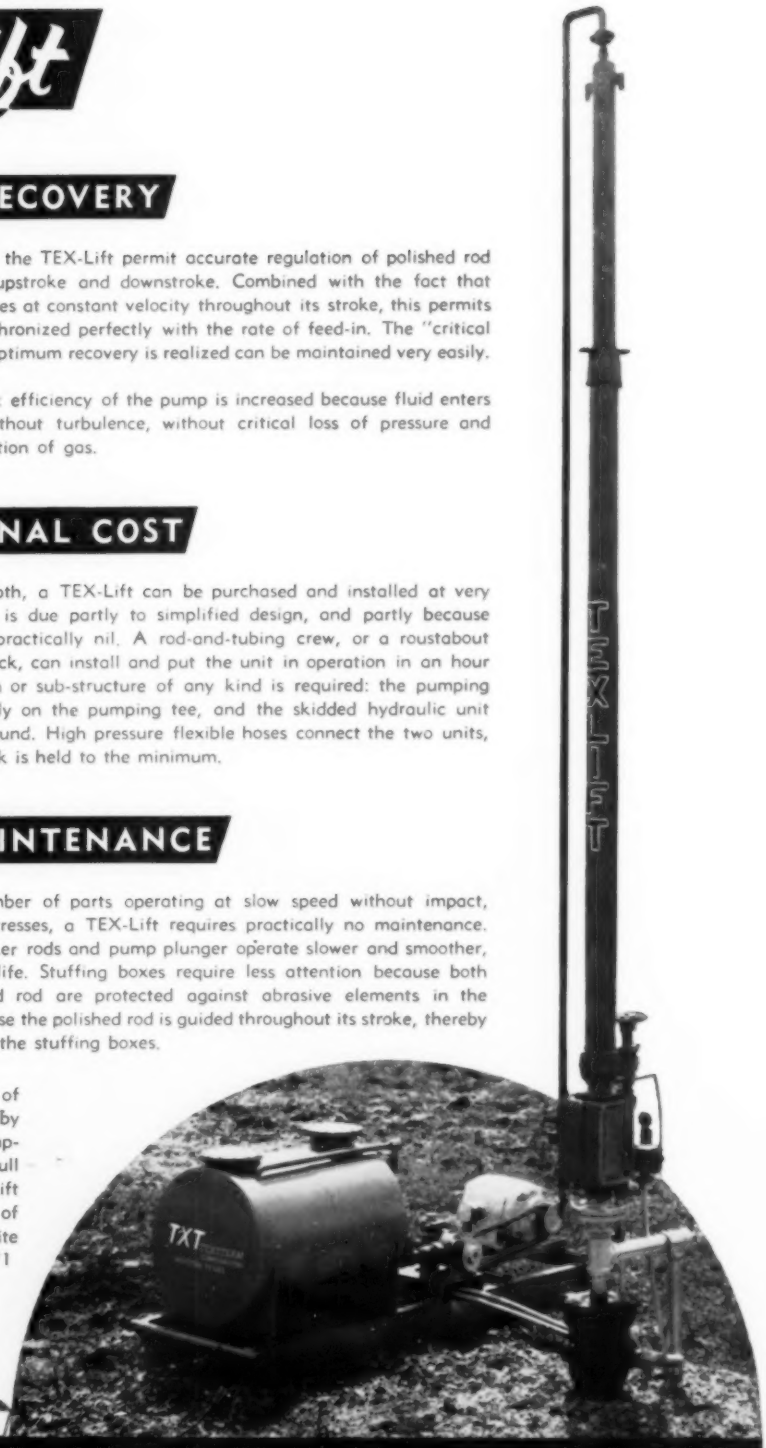

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THE WORLD'S FIRST prefabricated aluminum offshore drilling structure has been installed in Lake Maracaibo, Venezuela, for Superior Oil Company of Venezuela. Three additional platforms, the largest all-welded aluminum structures ever built, are now being installed for other operators in the Lake by J. Ray McDermott & Company, of Harvey, Louisiana, who designed and fabricated the units at its Morgan City yards. The initial structure rises 111 ft from the bottom of this oil-rich Venezuelan lake, while the others range up to 121 ft in height. They reach about nine feet above water level.

The aluminum platforms were specially designed by McDermott with the assistance of Reynolds Metals Company to overcome the problem of corrosion in Lake Maracaibo. Each single-well platform uses about 80,000 lb of aluminum. They have attracted much interest in the oil industry here because of their corrosion resistance, speed of installation, and the fact that they can be salvaged and moved to another location for new drilling operations.

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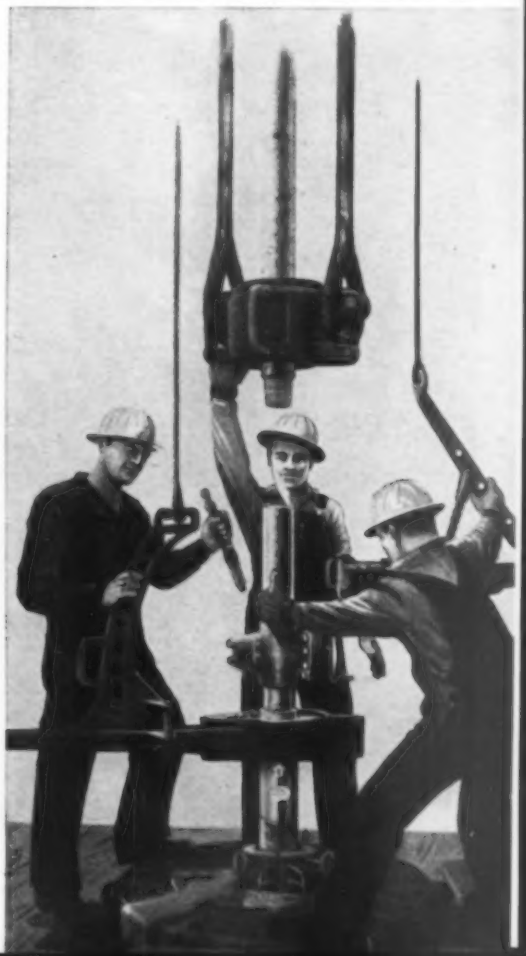

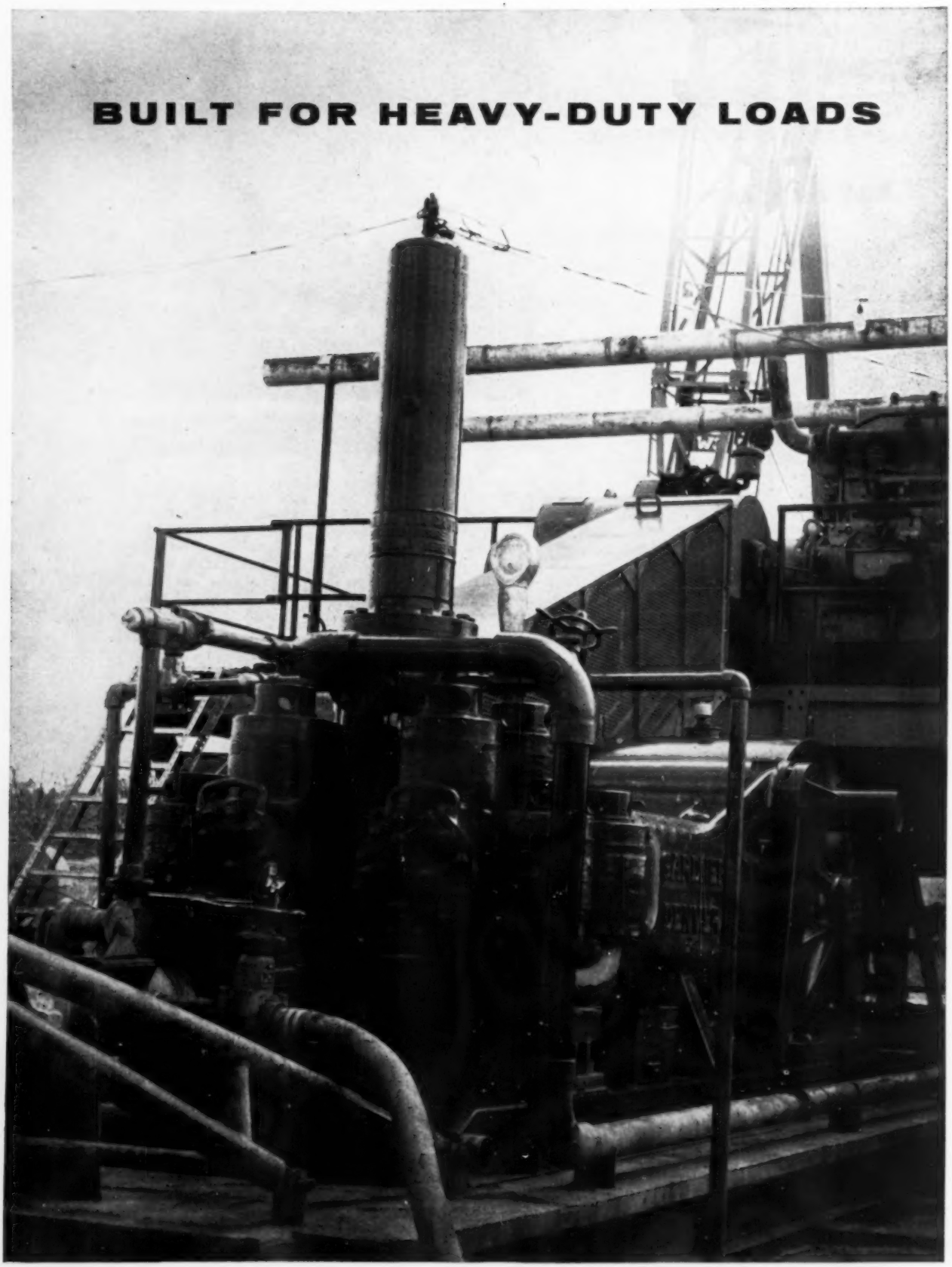

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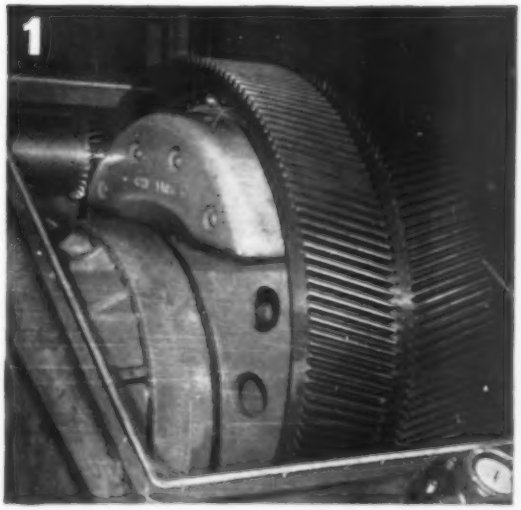

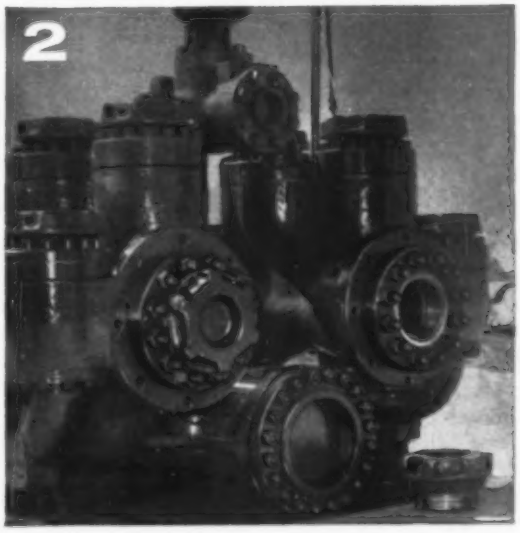

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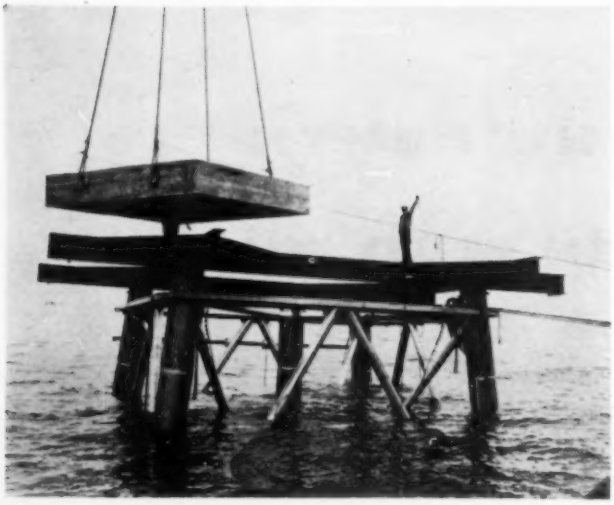
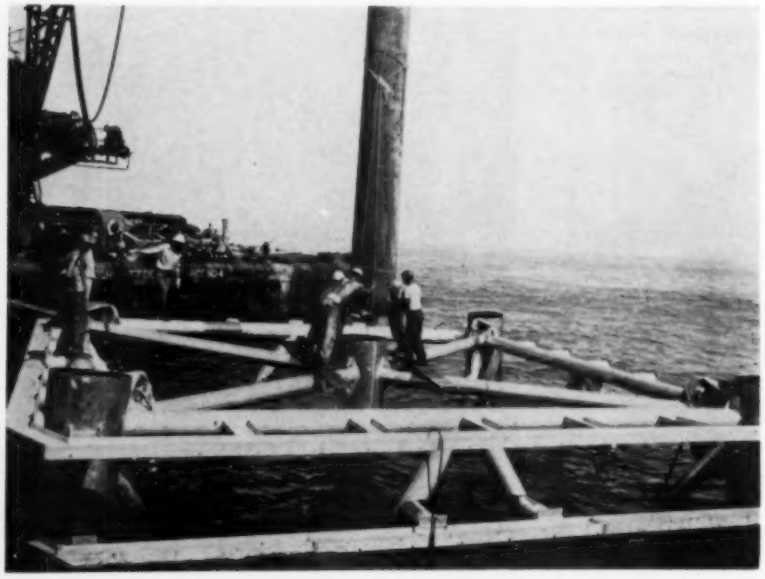


Forcing aluminum structure into lake bed by means of a 50-ton concrete slab. Weight of this slab rests on a temporary dead weight frame setting on top of the structure during this operation.



Steel conductor pipe guided into center column of all-aluminum structure template.

The first aluminum platform was erected in five days, and it is estimated that subsequent platforms can be installed in about three days each. Previously, most of the some 7000 Lake Maracaibo offshore derricks have been mounted on concrete piles, which require up to 25 days to install.

Lake Maracaibo's new type structures utilize aluminum jackets described as combining the structural strength of steel with the corrosion resistance and light weight of aluminum. The completed platforms have steel decking and steel piling, but all parts exposed to the water are made of aluminum.

Steel piles anchoring the platform are driven inside the four legs of the structure. Cement is poured in the space between the steel and aluminum.

The center full-length conductor guide, through which steel drill pipe is run, also is made of aluminum. Aluminum underwater lateral bracing adds strength and rigidity to the structure.

A number of design features in the aluminum jackets are of special engineering interest. Extruded aluminum saddles for the frame joints were especially designed to provide adequate stress transfer through these important intersections of the structure members.

A high-strength corrosion-resistant aluminum alloy that has been tested for several years in Lake Maracaibo is being used in the platforms. The alloy also has a long record of successful performance in sea water.

A combination of factors creates a corrosion problem in this Venezuelan lake. The narrow end of the pear-shaped lake adjoins the Gulf of Venezuela off the Carribean Sea. The current from rivers emptying into the lake keep its salt content quite low, and the river waters are rich in oxygen. The oxygen and certain chemicals in the lake bottom combine to produce a highly corrosive effect on ferrous metals. Only a relatively few steel drilling platforms have been used in the lake.

The aluminum platforms are being erected by J. Ray McDermott (Venezuela) C. A., the South American subsidiary. The towering structures were fabricated at Morgan City, Louisiana, and towed upright on a barge, across the Gulf of Mexico to Venezuela. A giant floating crane lifts them from the barge and lowers them into the waters of Lake Maracaibo.

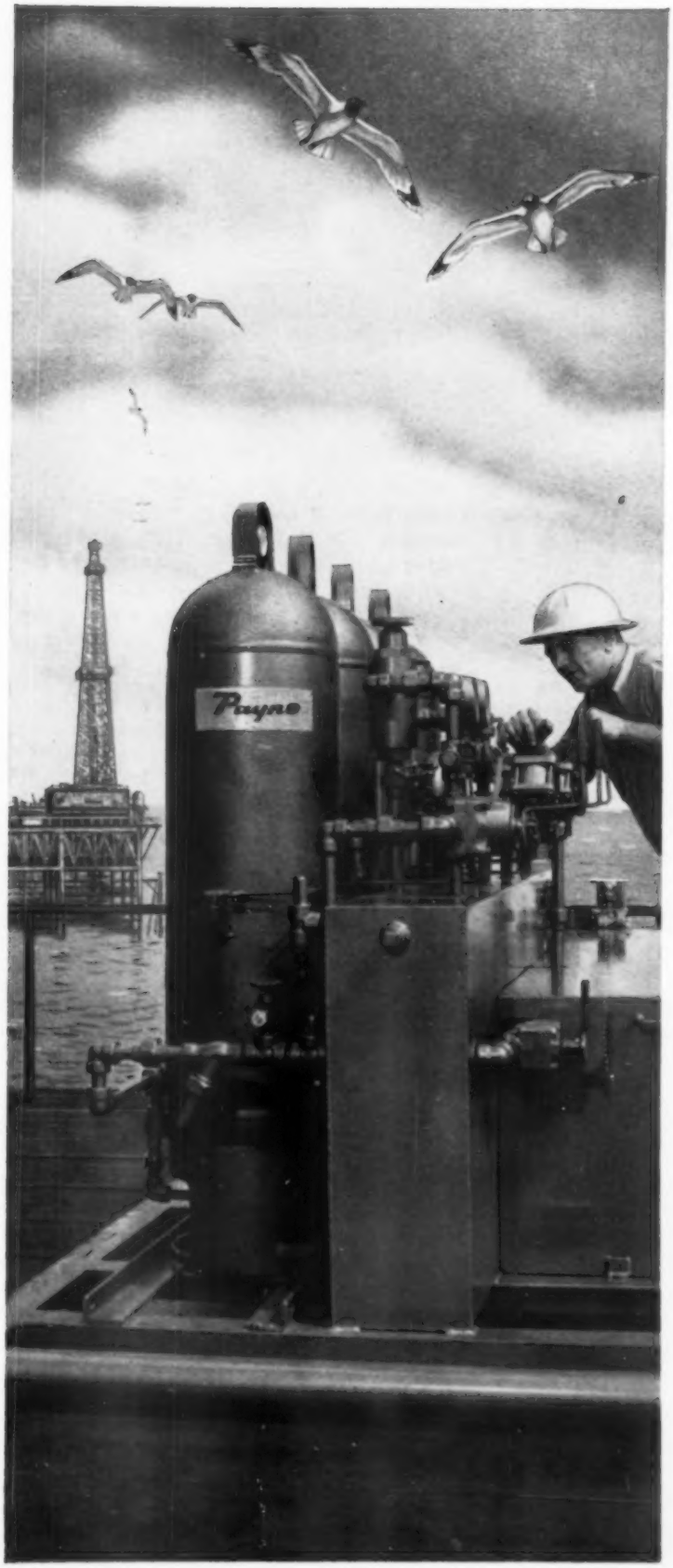
The first four of the new type structures are being erected under contract with oil firms drilling in the lake, one of the world's largest oil producing centers.

Charles L. Graves, vice president of McDermott, said more aluminum platforms already are being fabricated, and that he expects a widespread use of the new type offshore facility.

The aluminum platform can be picked up for relocation by severing the piling at the base, as is the standard procedure in shifting steel platforms. It can be removed and relocated for about one half of the cost of installing a new aluminum structure.

The initial installation was made for the Superior Oil Company of Venezuela. The second is scheduled for a combine consisting of Venezuelan Sun Oil Company (Operator), Pan-Venezuelan Oil Company, Venezuelan Atlantic Refining Company, and Seaboard Oil Company.

The other two are scheduled for the following combine: Signal Exploration Company (operator), Hancock Venezuela Oil Company, Pure Oil Company of Venezuela, Inc., and Sohio Venezuela Company. ★ ★ ★



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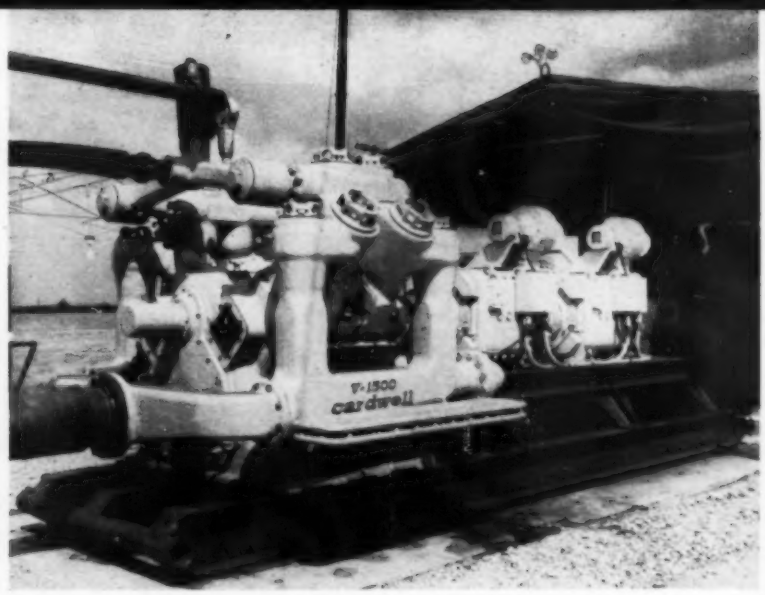

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- **Suction:** 12-in.
- **Discharge:** 4-in.
- **Dimensions:** 7 ft 1¼ in. long; 8 ft 1 in. wide; 6 ft 7 in. high

A NEW CONCEPT in mud pump design includes the application of aircraft criteria, light-weight castings, V-type construction and dual crankshafts. It is the V-1500, a new innovation in mud pumps, recently introduced by Cardwell Manufacturing Company of Wichita, Kansas. It is a unique pump for oil well service in that the rated input horsepower is high, and the weight is quite low, with an overall ratio of only 15⅓ lb per input horsepower, the lowest to date in industry for this type pump. Weight of the pump minus skid is just 23,000 lb; while rated input horsepower is 1500.

Among the unique features of the new V-1500 pump are such engineering innovations as four-cylinder, V-type construction, high speed operation and two-piece crankshaft. The pump is of plunger design eliminating pistons and fluid liners normally associated with mud pumps.

Fluid capacities. It is capable of handling at recommended operating speed, volumes of drilling fluid ranging from 626 gpm at 3500 psi discharge pressure to 1114 gpm at 2000 psi. This range of operation is accomplished by using four plunger sizes: 6-in., 5½-in., 5-in., and 4½-in. Fluctuations in the discharge flow are not increased by a change in plunger size. Although the pump may be operated at various speeds, the normal operating speed is 260 strokes per minute (spm), which is unusually high for pumps in this type service. The high speed permits direct coupling of motors or the utilization of chain drives at 1500 hp.

Discharge flow is unusually smooth because of the pump's four cylinders. The reduced flow variations are further minimized by the discharge frequency of the plungers of this high speed pump. This factor will materially reduce hydraulic hammer. Its V-type construction eliminates horizontal movement.

Changing plungers. Availability of four plunger sizes permits the pump

V-type construction of new pump involves dual crankshafts driving four plungers. Normal operating speed is 260 spm.

Performance chart of the new V-1500 mud pump, showing fluid output data for various operating conditions.

Pinion R.P.M.	Strokes Per Min.	Operating Data**	Plunger Size*** 6"	5½"	5"	4½"
840	280	G.P.M.	1200	1008	833	635
		P.S.I.	1963	2336	2829	3494
		Input H.P.	1615	1615	1615	1615
780	260*	G.P.M.	1114	936	773	626
		P.S.I.	1963	2336	2829	3494
		Input H.P.	1500	1500	1500	1500
720	240	G.P.M.	1028	864	714	578
		P.S.I.	1963	2336	2829	3494
		Input H.P.	1384	1384	1384	1384
660	220	G.P.M.	943	792	655	530
		P.S.I.	1963	2336	2829	3494
		Input H.P.	1269	1269	1269	1269

* Rated H.P. Based On 260 S.P.M.
** Based On 100% Volumetric Efficiency & 85% Mechanical Efficiency
*** Rod Load 55,500 Lbs.

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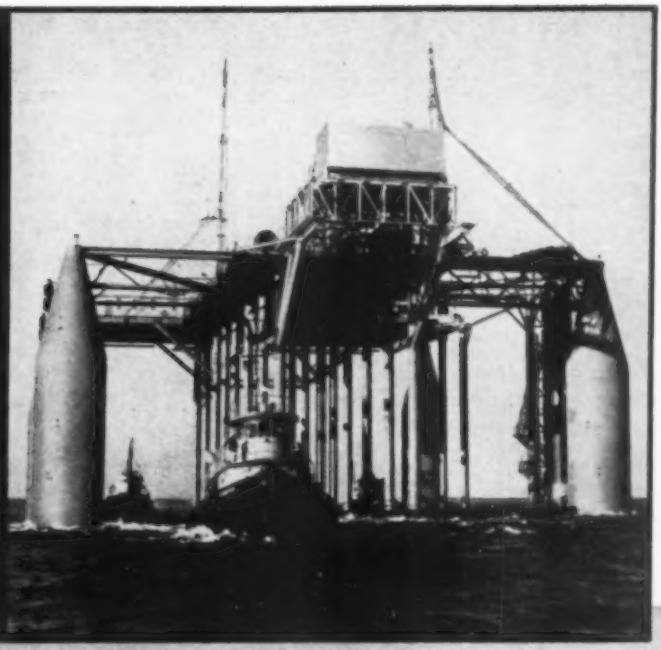

"Giant among giants" is the *Kermac 46*, among the largest submersible oil drilling platforms ever to go to sea! Built by INGALLS for Kerr-McGee Oil Industries, Inc., the *Kermac 46* has air-conditioned accommodations for a crew of 50 . . . can sink six wells without relocating in water up to 70 feet deep. If your offshore drilling job calls for imagination and economy, experience and technical skills . . . consult a specialist—INGALLS.

Now under construction at Pascagoula are two new submersible oil drilling platforms, both closely following the design of the *Kermac 46*. Pictured is the second section of the Movable Offshore Drilling Company's "rig." After being joined to a similar section in INGALLS Wet Dock, it will be outfitted and moved into the Gulf of Mexico for offshore drilling operations.

A third huge rig, "Blue Water #1," built by INGALLS for the Blue Water Drilling Corporation, was commissioned on September 6, 1957.

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to be operated in a range of pressures and volumes tailored to meet the changing conditions encountered in drilling a well. This "tailoring" of plunger sizes is readily accomplished after removing only the cylinder heads. A special packing arrangement permits bench assembly of the packing assemblies for easy installation when needed. A feature of the packing and packing arrangement is the pressure lubrication with its closed circulating system. This system in combination with the packing design permits positive lubrication of all packing rings resulting in materially prolonging the packing and plunger life.

Power input. Full power to drive the unit can be introduced at either end of the pinion drive shaft or power can be applied to drive the pump from both ends of the drive shaft.

Dual crankshafts. Another feature of the pump is its two crankshafts. As there are actually two crankshafts in the pump the load is divided into two plungers per shaft. This unique dual crankshaft design makes it possible to place the shaft support bearings on 13-in. centers. This close spacing of the load-carrying bearings eliminates the possibility of deflection or distortion of the crankshaft from the powerful thrusts of the plungers.

One-piece frame. The frame of this new pump is of cast, one-piece, all-steel construction thus eliminating bolted connections and insuring structural integrity. Fluid ends are of all-steel construction and are tested to 8000 psi. The very size and nature of the casings plus the strict requirements for lightweight castings, demanded new techniques and the services of one of the nation's foremost foundry organizations. These casting techniques were all confirmed by use of X-ray and other electronic measuring and testing devices.

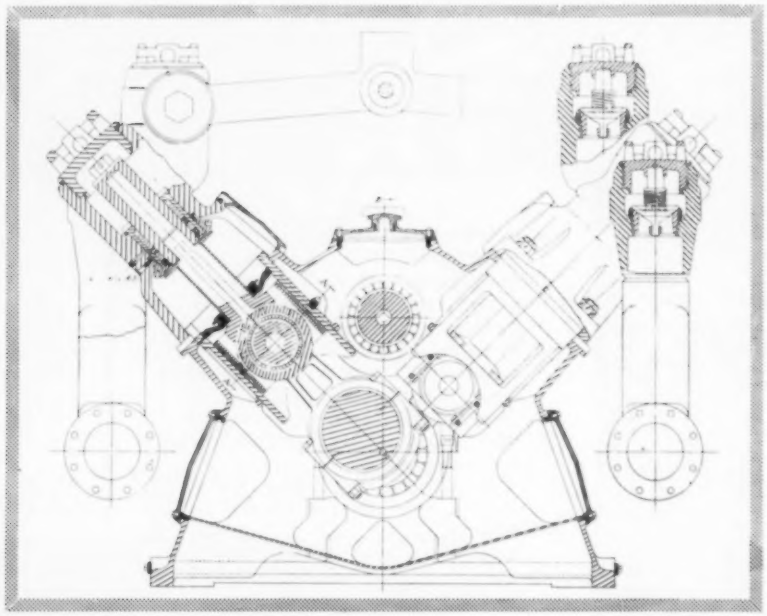
Lubrication. Lubrication to working parts is furnished by two oil pumps which are gear driven from the crankshaft. These pumps are parallel connected to insure continuous lubrication in the event one pump should become inoperative. In addition, an identical system with separate oil reservoir is used to supply lubrication to the plungers and plunger packing. By using two separate and distinct lubricating systems, contamination by foreign materials from the drilling fluid has been eliminated.

Mud seals. The power end of this new pump is fully protected against the intrusion of mud or other foreign material by four individual guards: (1) Large drains in stuffing box compartment located below seal level; (2) power frame stuffing boxes with multiple seals; (3) mud deflection baffles on the crosshead extension rods and (4) crosshead extension rods with exclusive renewable wear sleeves.

The cylinder heads and valve covers on the high-pressure fluid end are of threaded design for easy installation and removal. A confined type, high-pressure seal is used on these openings. These seals are located below the cover threads and prevent mud from reaching the threaded surfaces of the covers.

The pump has a bore and stroke of 6-in. by 8¾-in.; a 4-in. discharge opening and a 12-in. suction inlet. The pump measures approximately 7 ft long, 7 ft wide and 7 ft high.

Available next year. Cardwell officials said the pump will be in production by the first quarter of 1958, at a price per horsepower competitive with pumps now on the market.

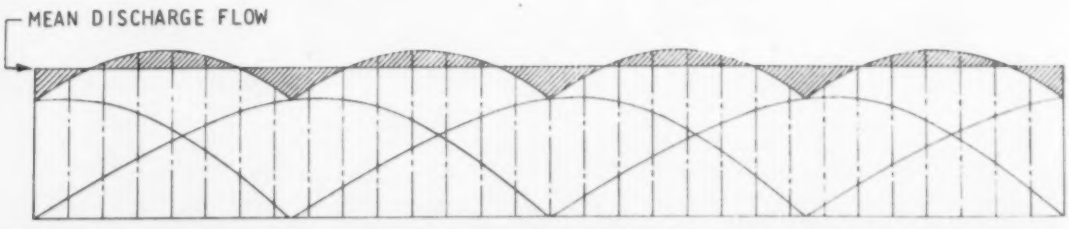


Cross-section through pump shows V-type design and arrangement of suction and discharge valves.

Diesel-Electric Drive

Although full power to drive the new pump can be applied at either end of the pinion shaft, or at both ends, in a recent demonstration of the new unit, two electric traction-type motors were used in tandem directly connected in-line to the pinion shaft. Each shunt-wound motor is rated at 685 hp continuous at 900 rpm, or 800 hp intermittently at 900 rpm. Due to the method of voltage control, these motors are able to deliver the necessary horsepower to drive the pump at its lower speeds.

Power for this demonstration hookup consisted of two ALCO 4-cycle turbocharged after-cooled diesel engines, each rated at 975 brake-hp at 1000 rpm. Each engine powered two 650 kw d-c generators with field windings of the differential compounded type which in conjunction with the excitation system design prevents overloading the generators and motors beyond safe limits. Excitation for the shut field is provided by individual exciters. ★ ★ ★



Discharge pressure diagram for one revolution of new quadruplex pump indicating a relatively smooth discharge characteristic.

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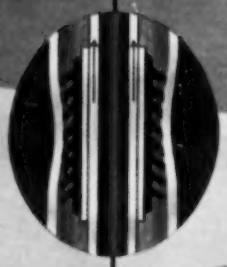
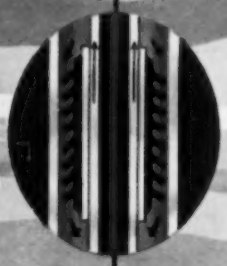


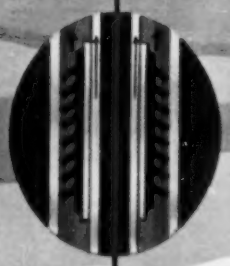
2. PASSES SMOOTHLY THROUGH TIGHT SPOTS

Flexible E-Z Swab Rubber fins allow swab to pass smoothly through tight spots on both up and down strokes.



3. RELEASES OVERLOADS

When load is excessive, fins bend down to bypass excess fluid. This safety relief action prevents overloads and broken wire lines.



4. LONG LASTING

After overload is bypassed, fins spring up until they seal. Wear is slow because fins seal against pipe with light contact pressure.

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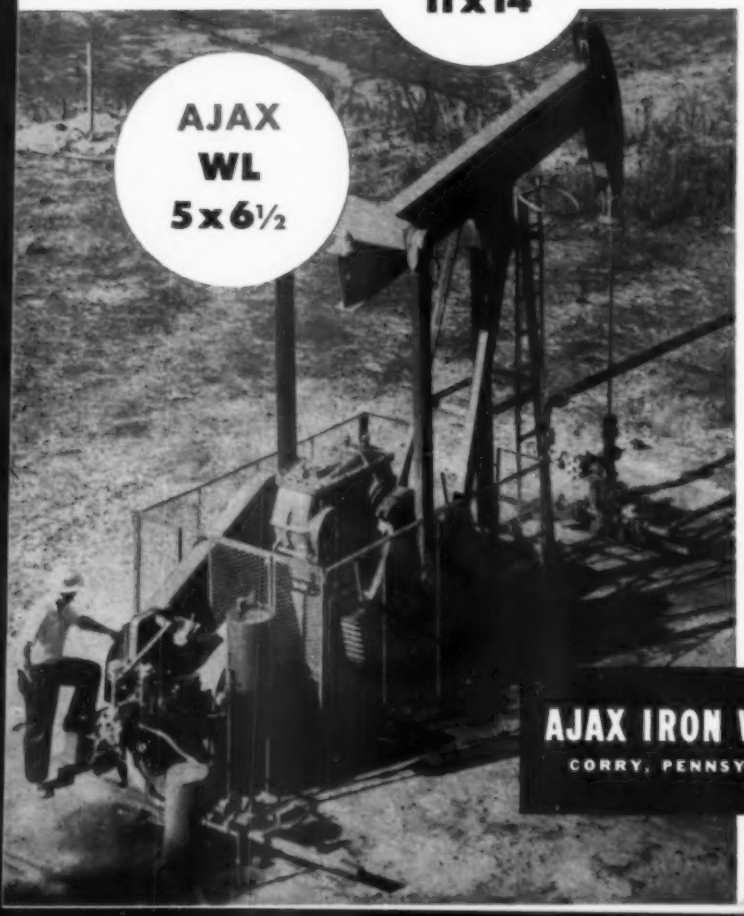

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A Key to Great Western Drilling Company's Success Is . . .

Effective Inventory Control of Drilling Equipment

J. E. Kastrop, *Editor*

Keeping track of the thousands of items that make up a large fleet of modern drilling rigs is no small chore. Here's how one successful West Texas contractor does just that . . . and makes maximum efficient use of all available equipment without needless duplication

THERE was a time, and to some extent it is still practiced today, when the label "Rig 1" or "Rig 2" was welded to most equipment items that make up a drilling rig. If a contractor operated two or more rigs, this identification prevented pilfering of equipment from one rig by another. Or, if the equipment was "loaned" temporarily to another rig for a special job, it was expected to be returned after a reasonable time. And, if not, the item could be easily identified by the welded label.

While this system might have served its purpose in days past, it is not effective in the proper inventory control of today's modern drilling rigs that are more complicated and consist of many more equipment items.

If you were to examine most any piece of equipment found on any of Great Western's fleet of modern rigs, you'd find such numbers as "86-11" stamped in a conspicuous place on the equipment item. This is one of the many code numbers employed in the company's unique system developed by the Inventory Department under the direction of Dave Fitzgerald, manager.

Not only has the system saved Great Western a sizeable chunk of money in getting maximum use from existing equipment, but has saved a lot of gray hairs in tracking down the thousands of items of equipment that make up and keep their fleet of rigs going at peak efficiency.

In this highly competitive contract drilling business today, the contractor must make maximum efficient use of all his equipment if he is to stay in business and make a respectable profit. And, this means shifting certain equipment from one rig to another without red tape delays where it is needed . . . in sizes and types that fit!

While keeping an accurate and up-to-date detailed inventory of all capital investment items, both assigned to active rigs and in the yards and warehouses, is a primary function of the Inventory Department, this is only a part of the Department's overall company responsibility in maintaining equipment records for all accounting purposes required in modern contract drilling.

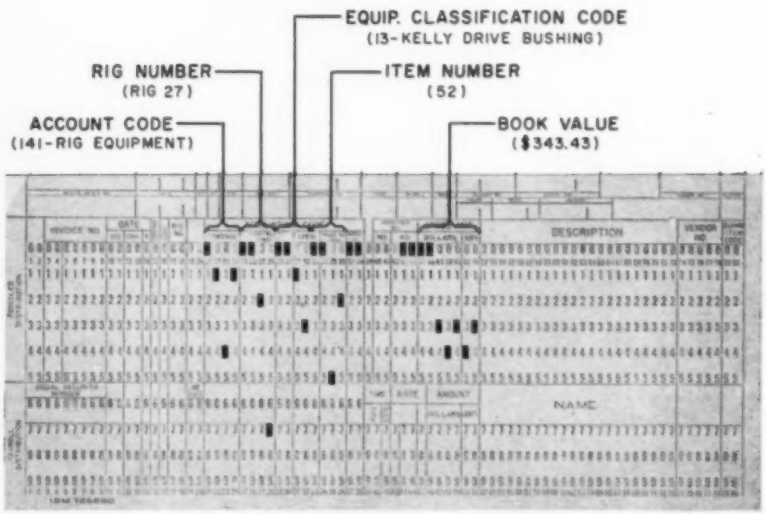


FIG. 1. **Typical punched card** for a single item of equipment. From such punched cards, inventories by rig numbers or by equipment classification can be printed in a relatively short time.

Inventory control purpose. The inventory group at Great Western is responsible for adequate records on all capital investment equipment showing (1) location, (2) identity, (3) availability, and (4) assisting in maintenance and repair expenses.

Basic Inventory Control System

Type of records to be maintained by the Inventory Department was not an easy decision to make. Too much book work and red tape would be just as costly as too little. The company has been in the contract drilling business for more than 20 years and had accumulated a great deal of experience in the type of records needed to provide the necessary information a multi-million dollar concern must have to operate intelligently in a highly competitive field. It was essential that the inventory records to be maintained be practical and useful, but not excessively burdensome with details and red tape as to become too costly and defeat its primary purpose. Great Western's unique equipment inventory system was nearly two years in the making, and is continually improved to meet new needs. The basic idea provides the flexibility to utilize the records for a number of important

inventory functions. It is closely tied in with accounting and engineering, and was recently expanded to include rig equipment maintenance.

How Equipment Is Identified

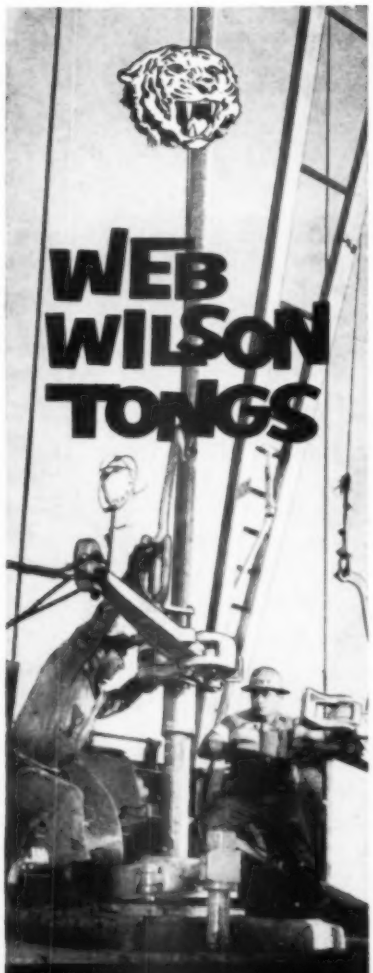
Identification of equipment is very important in any inventory system, and especially so for drilling equipment. A company serial number system was devised to identify every item of drilling equipment. The system included a code number which represented the general type of equipment. Numbers from 1 to 100 were used, and the following is the code used for some typical rig equipment items:

Type of Equipment	Code Number
Derrick	100
Drawworks	97
Drive Compound	96
Rotary Table	84
Mud Pumps	57
Crown Blocks	99
Hydromatic Brakes	94
Drilling Engines	93
Traveling Blocks	86
Overshots	71
Mud Gages	78
Shale Shakers	63
Electric Motors	62

To distinguish one drawworks from another, the number of that particular drawworks was added to the code number for drawworks. For example, drawworks 15 was given the equipment code number 97-15; the first number identifying the item as a drawworks; the second as the individual drawworks number. This number, 97-15, became the company's equipment serial number for their drawworks, number 15.

Serial number stamped on equipment. To save time in identifying a piece of equipment, the company serial number was stamped on the item in half-inch high numbers at a specified place. The only exception to this is the following types of equipment: Derrick floor, steps, V-door ramp, walks, lift subs, lift plugs, flowlines, pump liners, line pipe, jets, and mud guns do not have company serial numbers stamped on them.

Location of company serial numbers has been standardized so far as practicable so that when the equipment is covered with several layers of paint, the serial number can be located quickly. For example, in the case of hydromatic brakes, the number is stamped on the top of the case. On torque converters, this number is located adjacent to the manufacturer's name plate. Rotary hoses are stamped on both connections at each end. A complete description of company serial number locations for each type of equipment has been printed for company-wide distribution. Such a standard simplifies the job of initially stamp-



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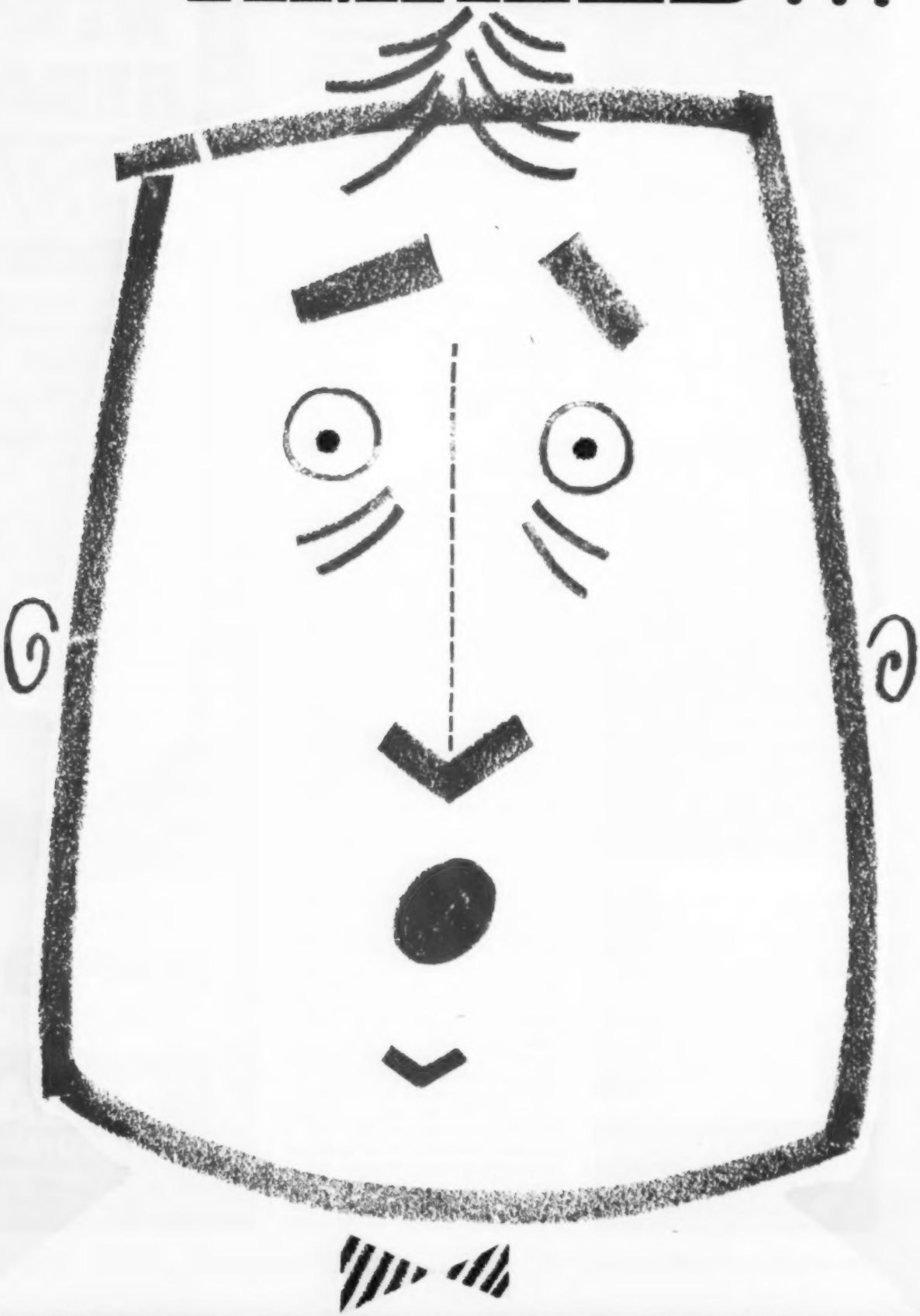

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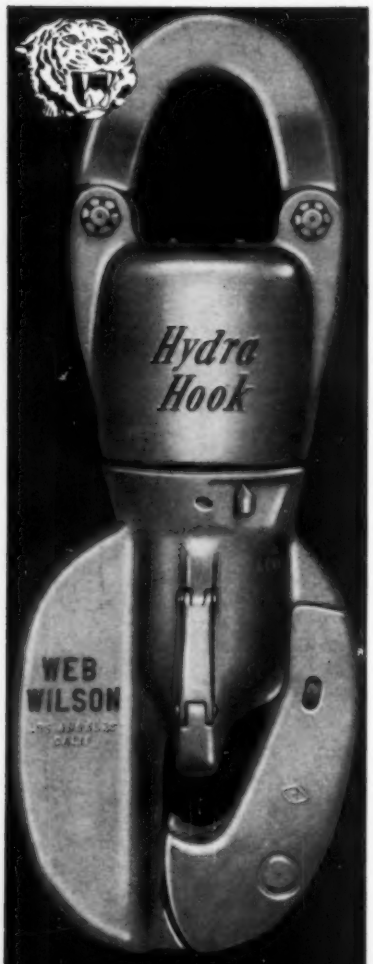

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Drilling equipment inventory specialist, Dave Fitzgerald, manager of Great Western's Inventory Department is responsible for keeping track of several hundred thousands of items that make up the company's large drilling fleet.

Master equipment inventory card file is being brought up to date by Howard Payne, assistant manager of the Inventory Department, who takes pertinent data from a recent equipment transfer order.

ing the company serial number on the item of equipment, and also simplifies the job of locating the serial number when identifying the item visually.

Five Account Codes Used

For inventory purposes, all equipment was grouped into five functional classifications. These are: 141 — Rig Equipment Account; 143 — Rig Auxiliary Account; 144—Rig Replacement Account; 170 — Surplus Supplies Account, and 556 — Rig Maintenance Account.

Rig Equipment Account 141. The account number 141 is used to identify all items of equipment that make up the actual working drilling rig, and does not include those items that may be used temporarily for a special job. On the inventory books, any rig equipment item is identified not only by the rig account number, but by the rig number to which that item is assigned, the company serial number and the value of the item. Here's an example of how a typical item of rig equipment is identified on the Inventory Department records:

141 — 16 — 50 — 111 — $48.10

The first series of numbers identifies the account number, 141 is the Rig Equipment Account. The second series of numbers, 16, identifies Rig 16 to which the item has been assigned. Third in the number of series is 50 which identifies the type of rig equipment, and in this case the item is a muderator. Next is 111, which is the individual equipment number of this piece of equipment, followed by the value of that item.

All items that make up the equipment compliment of a working drilling rig are divided into "major" and "minor" classifications for record purposes. Minor items are certain pieces of equipment that have a comparatively short life, and include: Slips, adapters, wire line guides, V-belts, drilling lines, pipe racks, suction hose, mud gages, rotary hose, etc. In assigning company serial numbers to new items that carry a minor classification, the new item replacing the old or junked item is assigned the same company serial number as that of the item it replaced. Any major item of newly acquired equipment is assigned a new company serial number.

Rig Auxiliary Account 143. The account number 143 is used to identify all items of equipment that are moved from one rig to another to perform a special job, but not necessarily permanently assigned to one specific rig. Some typical rig auxiliary items and their code numbers are:

Code Number	Description of Item
4	Elevators (all except 4½-in. and 7-in.)
11	Adapters, Flanges and Spools
82	Kellys (3½-in. and smaller)
67	Rotary Blowout Preventers
12	Kelly Valves

Other typical items included in this account are reamers, casing spiders, 8-in. drill collars, drilling-in equipment, rathole diggers, etc., and many more items that are required for special operations.

Rig Replacement Account 144. Drilling equipment, both major and minor items, stored in the yards or warehouses, that are available for permanent assignment to any company rig is assigned the account number 144. This number distinguishes all replacement equipment from rig equipment. However, anytime a rig replacement item is permanently assigned to a specific rig, that item is removed from the rig replacement account and transferred to the rig equipment account.

Surplus Supplies Account 170. This account number is used to identify surplus equipment supplies, such as mud pump liners, rods, pistons, overshot slips, different type valves, etc. These equipment supply items generally accumulate in company yards when sent in with pumps or when the well program changes. This account is primarily made up of mud pump parts pertaining to the pump's fluid end. A complete list of surplus supplies is printed each month and distributed to all company rig supervisors (Great Western's new personnel classification program no longer includes the tool pusher title, but has given emphasis on the tool pusher's responsibility by the new title of "rig supervisor"). The list of surplus supplies eliminates duplicate purchases of like items when they are needed.

Rig Maintenance Account 556. This account is handled by the Inventory Department in conjunction with other departments. Its purpose is to maintain accurate and complete records on repair and maintenance of all items of rig equipment bearing a company serial number. Information gained over a period of time will permit a more logical evaluation of equipment performance and costs. Equipment proved to be too costly to maintain will be replaced with like items that records show to be less costly to maintain.

Although the Inventory Department will keep the master records on this account, the information will come from the drilling superintendents and the rig supervisors whose responsibility it is to keep his equipment in good operating condition as well as to provide the in-

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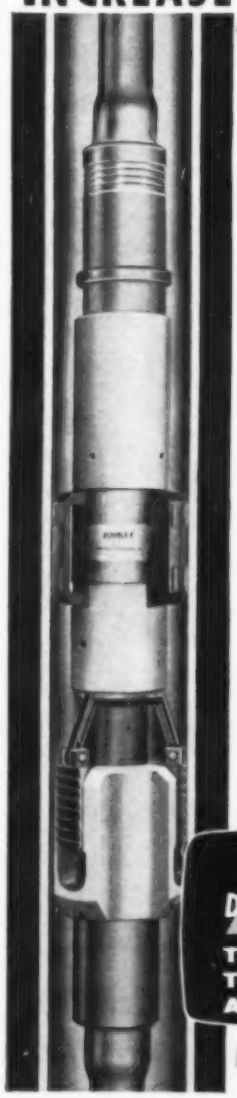

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formation needed to maintain adequate cost data on individual equipment items. Actual cost repair on a specific item is provided the drilling superintendent who passes the information on to the rig supervisor for his records. Not only will this method permit accurate repair costs data on each item, but it will keep the rig supervisor posted on the amount of money the company spends on repairs and maintenance for each item of rig equipment involved.

HOW RECORDS ARE SET UP

On New Equipment

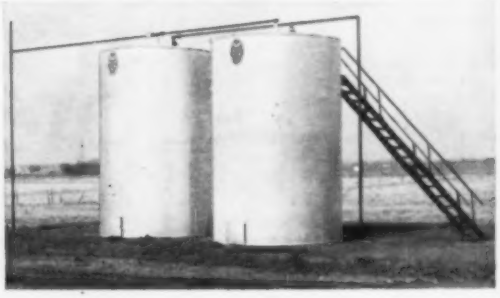
Expenditure requisitions. Before a new piece of equipment is purchased, an expenditure requisition is originated by the district drilling superintendent and approved by the district material supervisor along with the district drilling engineer. This expenditure requisition is mailed to the general office with copies to purchasing, accounting and inventory sections. It is first checked against the Rig Replacement Account (144) for availability of the item in company yards and warehouses. If the item is not available, the requisition is sent to the general manager of operations who confers with the engineering group and management in approval of the purchase. The approved requisition goes to purchasing where a purchase order is made and the item purchased.

When the equipment is delivered, either to a company yard or to the rig location, copies of the delivery ticket are left at the point of delivery where it is receipted by the district material supervisor (at company yards) or by the rig supervisor or drilling superintendent (at rig location). A company serial number is assigned by the district material supervisor to the item in accordance with the code system described earlier. This company serial number is noted on all copies of the delivery ticket. At this time the company serial number is also stamped on the new piece of equipment according to previously described procedures.

The district material supervisor prepares two duplicate equipment inventory cards (5 by 7 cards that indicate the type and make of equipment, the company serial number and the cost). One of these cards is kept in the district material supervisor's file and one copy goes to the rig supervisor (tool pusher). The delivery ticket is forwarded to the general office and is matched with the invoice. Upon receipt of the invoice and delivery ticket by the Inventory Department, the serial number is transferred to the original copy of the invoice. An equipment card is made for the master inventory card files.

The Inventory Department enters this new item with proper code designa-

A WISE CHOICE



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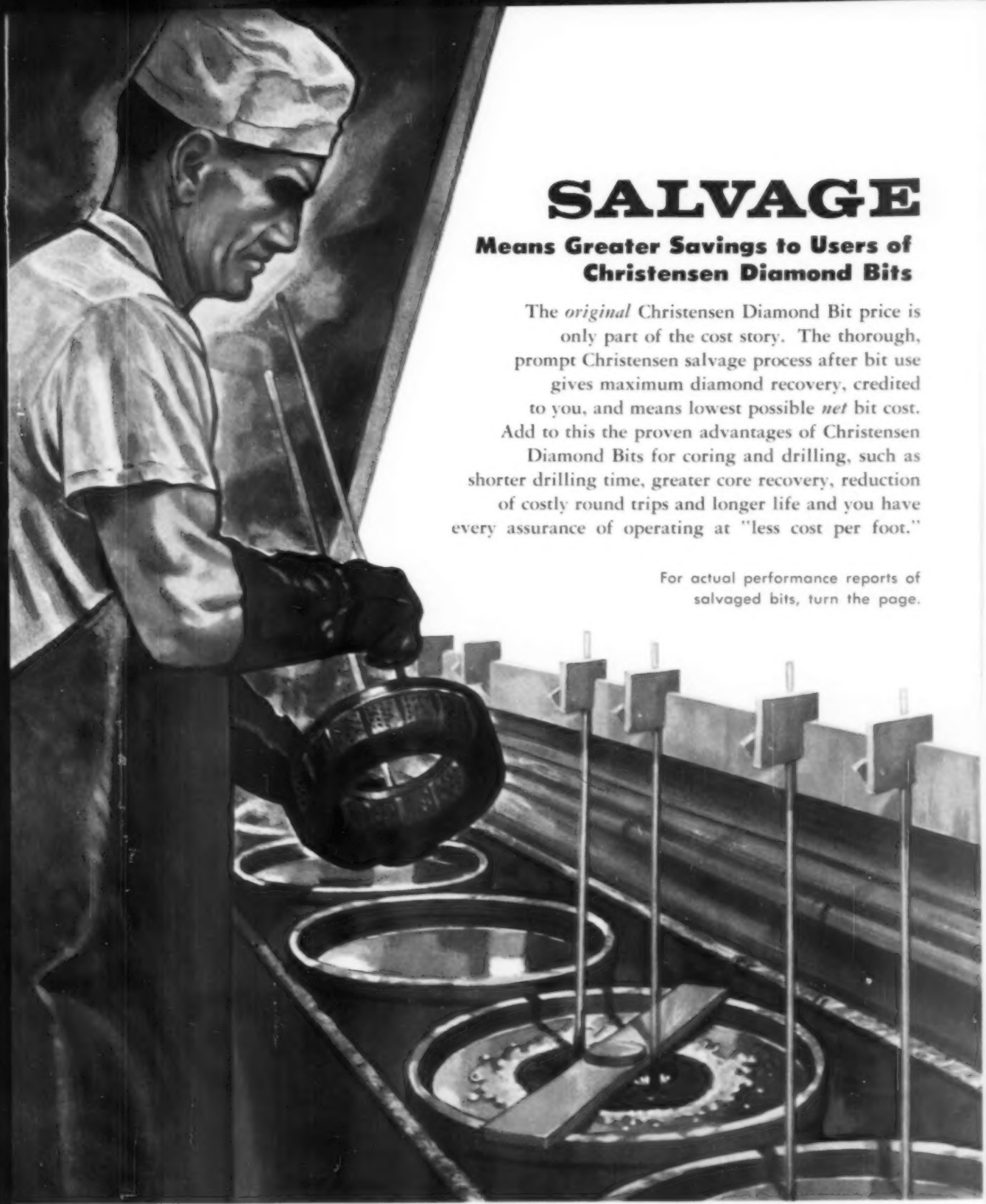

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For actual performance reports of salvaged bits, turn the page.

Illustration shows used bit ready for immersion in electric acid bath which releases the diamonds from the matrix metal.

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Diamond recovery rates

vary according to the condition of the used bit returned for salvage. No matter what condition the bit is in, the Christensen salvage process guarantees maximum diamond recovery.

When bit arrives for salvage a permanent tag is secured showing customer name, bit type and number and original carat weight.

Important steps in the salvage process shown here, first the shank is cut from bit crown, bit is immersed in electric acid bath and diamonds drop to bottom of tank.

Suction recovery from tank puts diamond into fine screen containers, then diamonds are meticulously hand sorted from foreign matter, accurately weighed, then credited to the customer.

Salvage reports of 4 different bits from diverse conditions

CORE BIT	5-9/16" x 2¼"
AREA	Sabine Parish, Louisiana
FORMATION	Fredricksburg - Wilcox
BIT PERFORMANCE	254 feet @ 2-8 ft./hr.
BIT CONDITION UPON RETURN FOR SALVAGE:	
EXCELLENT X GOOD FAIR POOR	
PERCENTAGE DIAMOND RECOVERY	59%
ORIGINAL BIT COST	$1674.30
NET BIT COST	$863.40
NET BIT COST PER FOOT	$3.39

CORE BIT	7⅛" x 3½"
AREA	Wichita County, Texas
FORMATION	Cisco Sand
BIT PERFORMANCE	697 feet @ 6 ft./hr.
BIT CONDITION UPON RETURN FOR SALVAGE:	
EXCELLENT X GOOD FAIR POOR	
PERCENTAGE DIAMOND RECOVERY	63.3%
ORIGINAL BIT COST	$2846.99
NET BIT COST	$1298.94
NET BIT COST PER FOOT	$2.01

CORE BIT	8⅝" x 4"
AREA	Roosevelt County, Montana
FORMATION	Lime, Dolomite
BIT PERFORMANCE	400 feet @ 2-6 ft./hr.
BIT CONDITION UPON RETURN FOR SALVAGE:	
EXCELLENT X GOOD FAIR POOR	
PERCENTAGE DIAMOND RECOVERY	67.3%
ORIGINAL BIT COST	$3788.05
NET BIT COST	$1507.45
NET BIT COST PER FOOT	$3.77

CORE BIT	6½" x 3½"
AREA	Weld County, Colorado
FORMATION	D & J Sands
BIT PERFORMANCE	407 feet @ 3 ft./hr.
BIT CONDITION UPON RETURN FOR SALVAGE:	
X EXCELLENT GOOD FAIR POOR	
PERCENTAGE DIAMOND RECOVERY	80.2%
ORIGINAL BIT COST	$1500.36
NET BIT COST	$697.11
NET BIT COST PER FOOT	$1.71

1937 South 2nd West Salt Lake City, Utah

CHRISTENSEN DIAMOND PRODUCTS

tions on its records. The invoice along with a copy of the delivery ticket then goes to the Accounting Department where payment is made and the delivery ticket sent to the business machine accounting group where the information is punched on business machine cards.

Equipment card file. Individual equipment information showing type of equipment, make and model number, manufacturer's serial number, company serial number, invoice number, when purchased, cost and location of the item is entered on 5 by 7 cards. A master file of these cards on every equipment item representing a company capital investment is maintained in the Inventory Department at the home office in Midland. One set of these cards is kept at the district office by the district material supervisor, but here the cards represent only the equipment located within the district. The rig supervisor (or tool pusher) is given a complete set of cards which are kept current so he will know at all times the identity and status of equipment under his jurisdiction. And, since he is fully responsible for all equipment under his supervision, this card file is a valuable record for him.

Transfers within a district. When needed equipment items are available within the company, and requested by either the rig supervisor or the drilling superintendent, the district material supervisor checks his card file to determine if that item is available within the district. If it is available, the material supervisor arranges transportation and writes a transfer order. If the item is in the yards or warehouse, the district material supervisor has both cards on that item. (If it had been assigned to a particular rig in the district, the card on that item would be in the rig supervisor's file.) The truck driver loading the item from the yard is given copies of the transfer order and the duplicate card showing all pertinent data about that item of equipment.

At the rig, the transfer order is receipted by the rig supervisor (or driller) and he keeps the equipment record card for his rig files. The receipted transfer order is returned to the district office where the original is filed and a copy initialed by the district material supervisor is returned to the rig. One copy of the transfer order is sent to the general office in Midland where it is posted on the inventory cards and forwarded to the Accounting Department for their use.

To remove old equipment from the rig due to mechanical failure, a transfer order is written by the rig supervisor (or driller). Copies of the transfer order and the inventory card on the item are given to the truck driver who brings the old item to a district yard where it is received by the district material supervisor. The original receipted copy of the transfer order is filed in the district office, and one copy is returned to the rig. The inventory card on the old item is placed in the card file behind the district office's duplicate card on this item. A copy of the receipted transfer order is sent to the main office for posting on the master inventory cards and forwarded to the Accounting Department for correcting their records.

In case of equipment failure that can be repaired, a copy of the transfer order goes to the Maintenance Department with a notation referring to the type of failure. On some items, such as blowout preventers, overshots, weight indicators, elevator tongs, drill pipe and drill collars, the Inventory Department is responsible for their repair. Equipment repaired by the Inventory Department must be accompanied by an expenditure requisition or shop job estimate approved by the general office, except in the case of minor items.

Inter-district equipment transfers. If a particular piece of equipment is needed by a rig in one district which does not have that item available, the district material supervisor consults the home office for availability of the item from other districts. A search is

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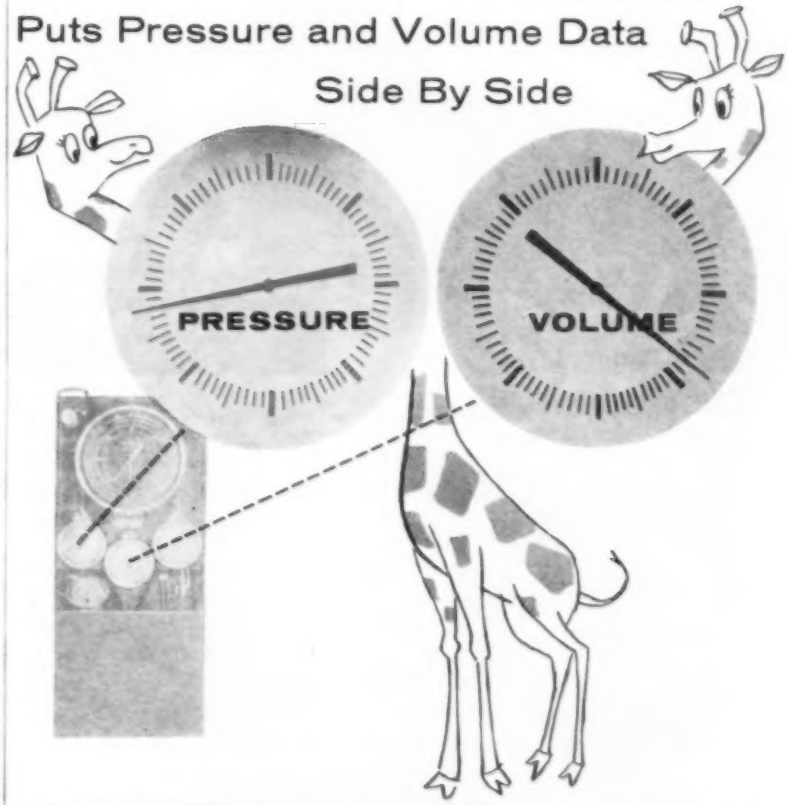

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made of the master inventory card files. If the item is found to be available in another district, that district material supervisor is notified by radio or telephone to ship the item to the rig requesting it. This is one of the many instances where accurate records pay off. The item must be of the correct type and size, and the cards are relied upon for this information.

When an item is moved from one district to another, the transfer order originates with the district material supervisor from which the item is shipped. This order is based upon the authority of the Inventory Department of the home office. The original copy of the transfer order along with one of the inventory cards goes with the shipment of the equipment direct to the rig. One copy of the transfer order and the duplicate inventory card is sent by mail to the district material supervisor of the district in which the equipment is to be used. The Inventory Department at the home office gets a third copy of the transfer order properly receipted in the receiving district. Home office records are corrected accordingly.

Use of Business Machines

For the past eight years, Great Western Drilling Company has maintained on a lease rental basis an extensive array of modern electronic business machines. The business machine group, headed by Bob Hill, manager, performs numerous functions to serve the Accounting Department, the Inventory Department, the Engineering Department, as well as any other department where its service can be utilized to an advantage. Although its equipment inventory function is but a small part of its overall operation, it is an important one, and a job it can handle well and at a tremendous saving in time.

Fig. 1 shows a typical punched card which carries individual equipment data used for inventory purposes. Note that the punched card contains the same information as shown on the records of the Inventory Department. This example serves to show how the account number, the rig number, the equipment classification code number, the individual item number and the cost of the item is punched on the business machine cards.

These cards are punched by the punch card operator who takes the necessary information from copies of equipment transfer orders obtained from the Inventory Department, or from receipted invoices in the case of new items. New cards are put in their proper place in the master punched card file by means of a sorter machine and can be called on at any time for any information they might contain.

Reports from business machine group. It doesn't take these business machines very long to print out just about any type of information needed, provided that information has been punched in the individual cards.

The business machine group each month prints out a current equipment inventory list of all equipment on each individual rig by rig numbers. The control panel on the computer section of the machine group is wired to provide the desired data by rig numbers. And, the printer comes out with a completely typed inventory list, item by item, with all data on the sheet, for each rig. These printed inventory lists are used to check and double check the correct identity, location, and description of all equipment on every rig, and serve the Accounting Department in its records. It is from such a list that depreciation values are determined for proper cost accounting. Such a system provides an accurate and quick way of providing this information. Equipment not assigned to any particular rig is not included in the depreciation value for that particular well.

Also, the business machine group provides a monthly inventory list by equipment types. For example, the computer section of the machines will be wired to take a complete inventory

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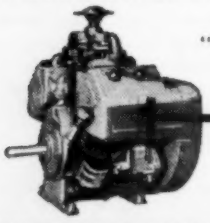

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Rig inventory list "rolls out" of the business machine printer under the watchful eye of Bob Hill, manager of the business machine section. A complete rig inventory list can be printed in less than an hour.

Business machine cards are punched by Mickie Roberts of the business machine section. Information as to the identity, location, cost, etc., comes from invoices and transfer orders.

of all kelly drive bushings (code number 13). The master cards are run through the machines and the printer prints out item by item a list of every kelly drive bushing the company owns, showing the number of each particular kelly drive bushing (which makes up part of the company serial number), on what rig it is located, the account number, as well as the cost of the item. This is done on all types of equipment.

Inventory Reports

What has been described above is basically how the inventory system at Great Western Drilling Company is set up and how it works to keep current account of all capital investment equipment throughout the company's operations. At the first of each year, the Inventory Department makes a personal visual inventory of every rig in operation. This is done under the direction of district material supervisors. Information provided by this annual inventory is another check for accuracy of records, and if any discrepancies are noted, they are rectified.

The Inventory Department also makes twice a year rig inspection reports. These reports are primarily concerned with the condition, upkeep and proper application of all rig equipment. In addition, the district material supervisor makes a monthly "rack" inventory of drill pipe and drill collars to make sure that all records are correct.

When a New Well Is Drilled

Another function of the Inventory Department involves setting the stage to start a new well on which a contract has been signed. The manager of the Inventory Department meets with the general manager of operations, the general drilling superintendent and the chief drilling engineer. Rig equipment requirements are established, and the

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Inventory Department manager reports on the completeness equipment-wise of the rig available for this particular well. If additional items are needed, the procurement process as outlined previously is initiated. Once plans have been made and approved, all pertinent data on the new well are forwarded to the district drilling superintendent who meets with the district drilling engineer and district material supervisor. Here, all the equipment requirements for the rig are outlined so that the material supervisor might have adequate notice of requirements for special items. For, he has the job of getting the required tools for every phase of the drilling operation.

Other inventory functions. Outside of its primary responsibility, the Inventory Department performs many important assignments. It maintains separate records on all drill pipe and drill collars, keeping up with their service life, storage, as well as maintenance and repair costs. In addition, service reports are maintained on all company electric light plants, drilling engines, plus publishing for the benefit of the company's contract representatives, a monthly summary inventory of each rig. This inventory list includes major items only.

The Inventory Department is also responsible for all company buildings, including those dwellings located on company leases and at company yards. And, since Great Western also has oil and gas production, the Inventory Department has the responsibility of maintaining equipment inventory records of all production equipment in a similar manner as described above. Dave Fitzgerald, manager of the Inventory Department sums up his department's job this way: "We're responsible for all proper inventory records required on all company capital equipment investment accounts." And, for Great Western, this isn't an easy job.

Inventory Department Personnel

To carry out its many responsibilities, including those related to inventory functions, Great Western's Inventory Department consists of eight men, including the manager and assistant manager of purchasing and inventory, three district material supervisors, two field material clerks, and a home office clerk.

It was long recognized by the company that to execute a smooth-functioning inventory department and eliminate confusion, those charged with inventory responsibilities must know their job and know it well. So, the Inventory Department set up a training program for all men in its department and for all those that join the department in the future. Trainees go through a 46-week training period, spending a varying amount of time in every phase of the company's operations. He starts with the company roustabout crews (18 weeks), then a floorman on a company rig (16 weeks), in the company shops, with the field mechanics, the Drilling Engineering Department, and then in the Inventory Department. When he finishes this program, he will have a better understanding of the company, how it operates, and how the records are made and kept, and what they are used for.

Another competitive requirement. This is but a quick inside look at one department of a progressive drilling contractor. But, it is representative of how far the contractor has come in operating his business and what he must do, in one form or another, to keep accurate accounting of every phase of his work in order to stay afloat in a highly competitive industry.

Acknowledgment

THE PETROLEUM ENGINEER is grateful to the management of Great Western Drilling Company for permission to obtain this information and to publish this article. The author thanks Dave Fitzgerald and his Inventory Department for their generous aid. ★ ★ ★

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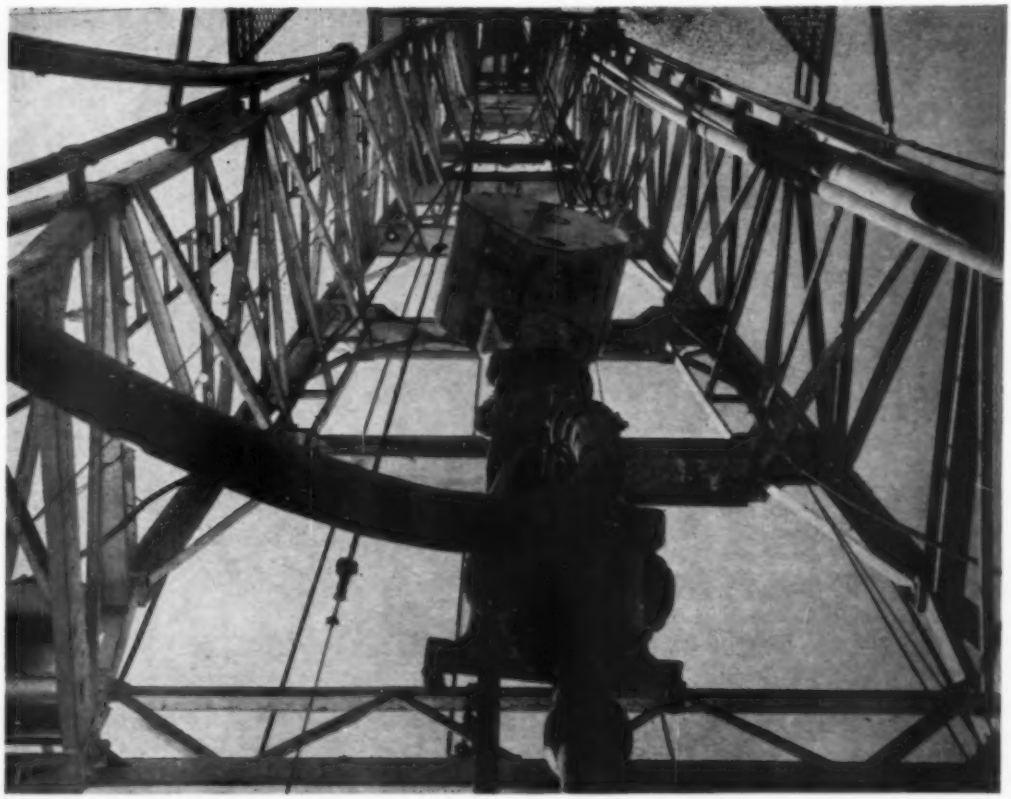
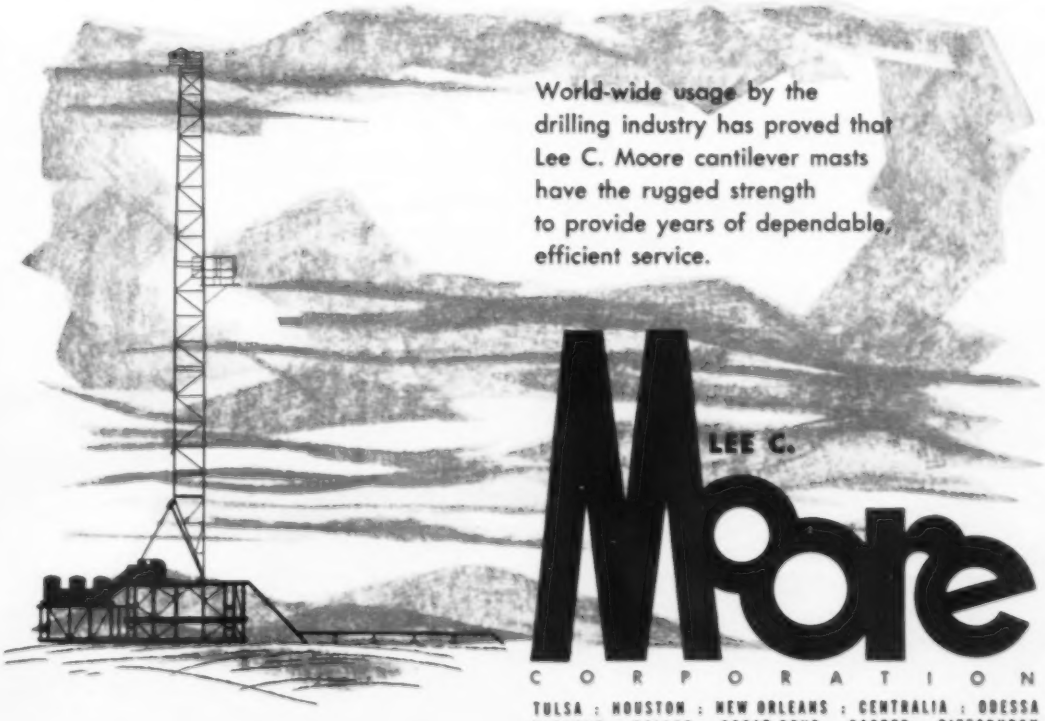


RUGGED STRENGTH



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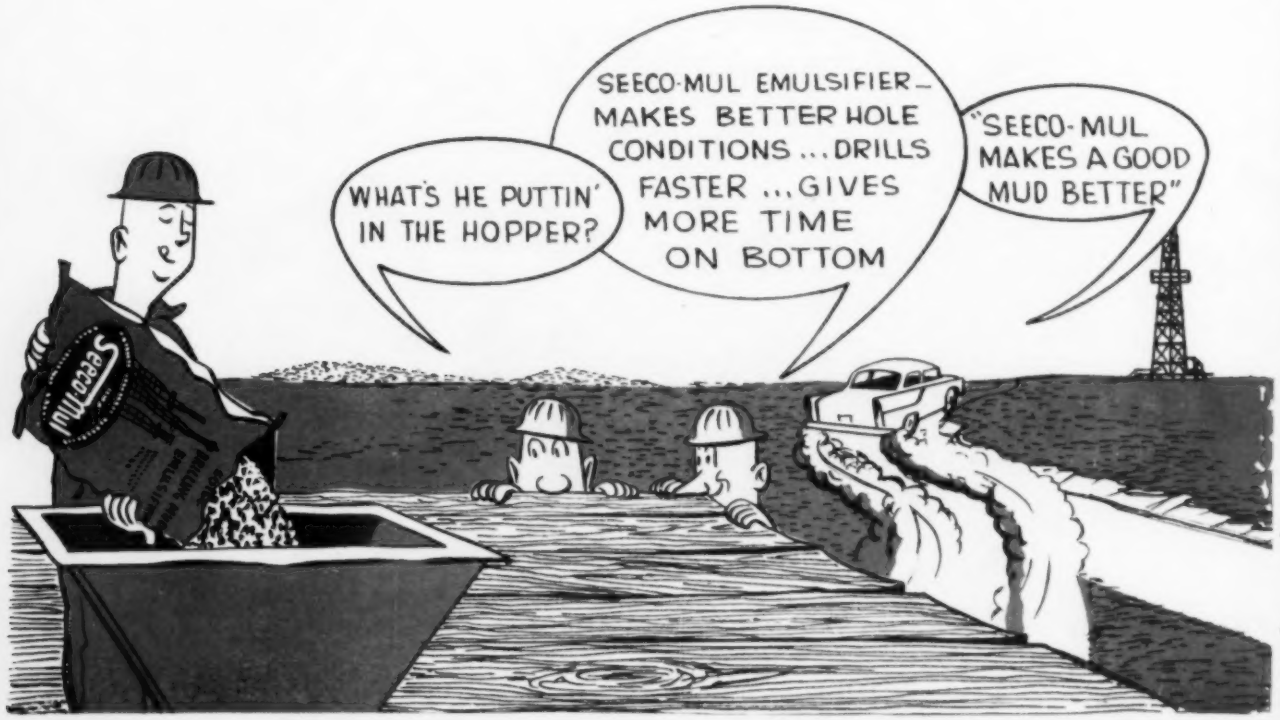
WORLD–WIDE OFFSHORE FLEET GROWS

Stancal's Multi-Well Platform

A $2,000,000 drilling platform is to be constructed by Standard Oil Company of California on the state's offshore oil lease near Summerland, California. The structure will have a 110-ft square deck, stand 50 ft above the water line, and be topped by a 140-ft derrick during drilling operations. It will be capable of drilling two wells simultaneously, and up to a total of 25 wells from the same location. It's the first such structure to be erected under the state's program for oil development on certain of its offshore lands.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"SEECO-MUL MAKES A GOOD MUD BETTER"
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Natural Gas & Oil's "Ray Terry"

The second shallow-water drilling barge to be placed into service by Natural Gas and Oil Company was christened in mid-July at the Bethlehem Shipyard, Beaumont, Texas.

Named the "Ray Terry," the new diesel-electric drilling unit is named for the vice president in charge of Natural Gas and Oil Company, a Division of Mississippi River Fuel Corporation. Measuring 215 ft in overall length, and costing approximately $1,500,000, the "Ray Terry" is the largest slotted-type barge to be built in the Bethlehem yards, and is capable of drilling to depths in excess of 20,000 ft. The area of operations for the new unit will be on Southern Louisiana inland waters, where its predecessor, the drilling barge "Roscoe Hobbs," has been working for Natural Gas and Oil since its commission in 1955.

The 1100-ton vessel is of all-welded steel construction, has a loaded draft of 4 ft 6 in., a breadth of 52 ft, and is rated to drill in 14 ft of water.

Configuration of the "Ray Terry" is that of a standard tri-level drilling barge. Installed on the lower deck are the six turbocharged diesel engines which supply complete power for the vessel's operation. Four of these engines supply power for the operation of the mud pumps, drawworks and rotary table and are mounted in the forward portion of the main machinery area. These engines are equipped with two-bearing d-c drilling generators, which deliver current to electric motors powering the drilling components.

Also located on lower deck are three mud pumps. A motor control center, located in the main machinery room, provides exercise of central control over such rig auxiliary equipment as shale shakers, mud agitators, flash mixer, fresh and salt water pumps, fuel oil pumps, compressors, vent fans, and motor-generator sets.

The drilling platform, located amidships and elevated above the superstructure deck, is fitted out with a 147-ft derrick having 30 ft leg spread. The drawworks, mounted forward on the drilling floor, is equipped with a shaft rotary drive assembly to drive a 27½ in. rotary. All necessary electrical controls were incorporated into the drawworks control console to provide the driller with complete control of the d-c generator output from the drilling floor.

The forward portion of the superstructure deck serves as the pipe rack, and contains an initial stock of 14,000 ft of 5-in. OD Grade E drill pipe.

Toolpusher assigned to the "Ray Terry" is Gene Hazelwood.

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One of the reasons for the current trend toward emulsion muds is the better hole conditions the systems afford. In almost all areas, emulsion muds increase drilling rates, make better hole conditions, drill into pay formations better, afford better coring, and protect the pay zone from water more effectively. Such factors are easily projected into substantial cost and time savings.

A Seeco-Mul mud has an exceptionally low filtration rate because the oil in the emulsion is effectively dispersed and the pores of the filter cake are plugged by a tough film. Holes can be drilled more nearly to gauge, with fewer and smaller washed-out areas. A hole drilled to gauge size also requires less mud, and less cement for the oil string. Seeco-Mul builds up a tough, thin wall cake which reduces fluid loss and sloughing and heaving in shale formations. And once a Seeco-Mul emulsion mud system is established, no special maintenance is required; only routine testing and treating is necessary.

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Seeco-Mul *emulsion muds drill faster, better, save drilling costs*

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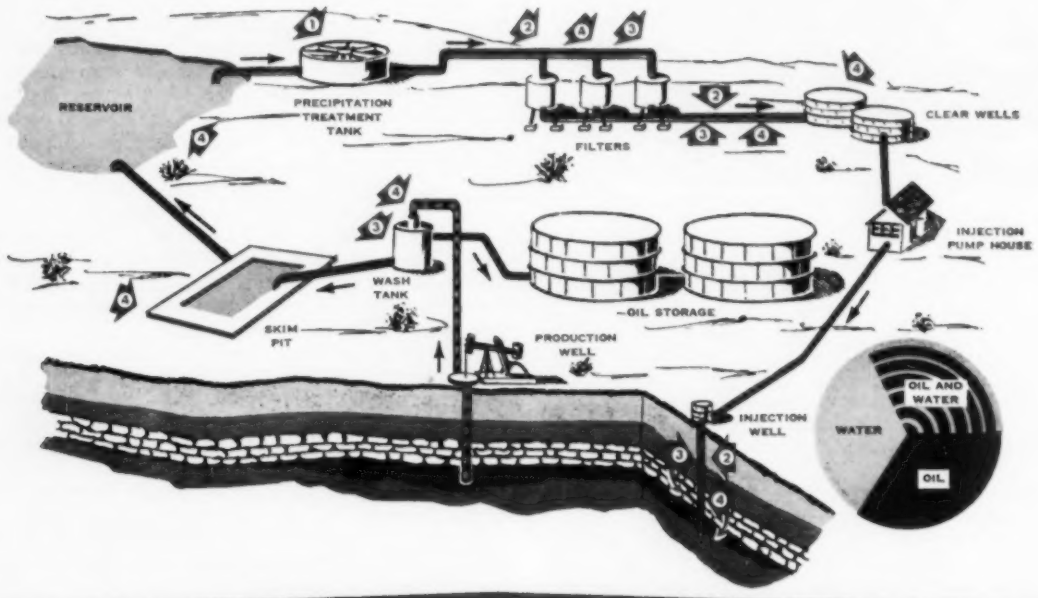

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Nalco microbiological treatments help maintain clean equipment and an open formation by controlling slime, algae and sulfate reducing bacteria.

Nalco Treatments for water flood operations add up to continuous high input, low pumping costs, elimination of acidizing and back flushing and lower over-all operating and maintenance costs. Check the diagram above for points where the Nalco System works to improve water flood efficiency... Your Nalco Field Service Man will be glad to work with you on any problems you have. His experience is backed by the entire facilities and skills of the world's largest water treatment organization.

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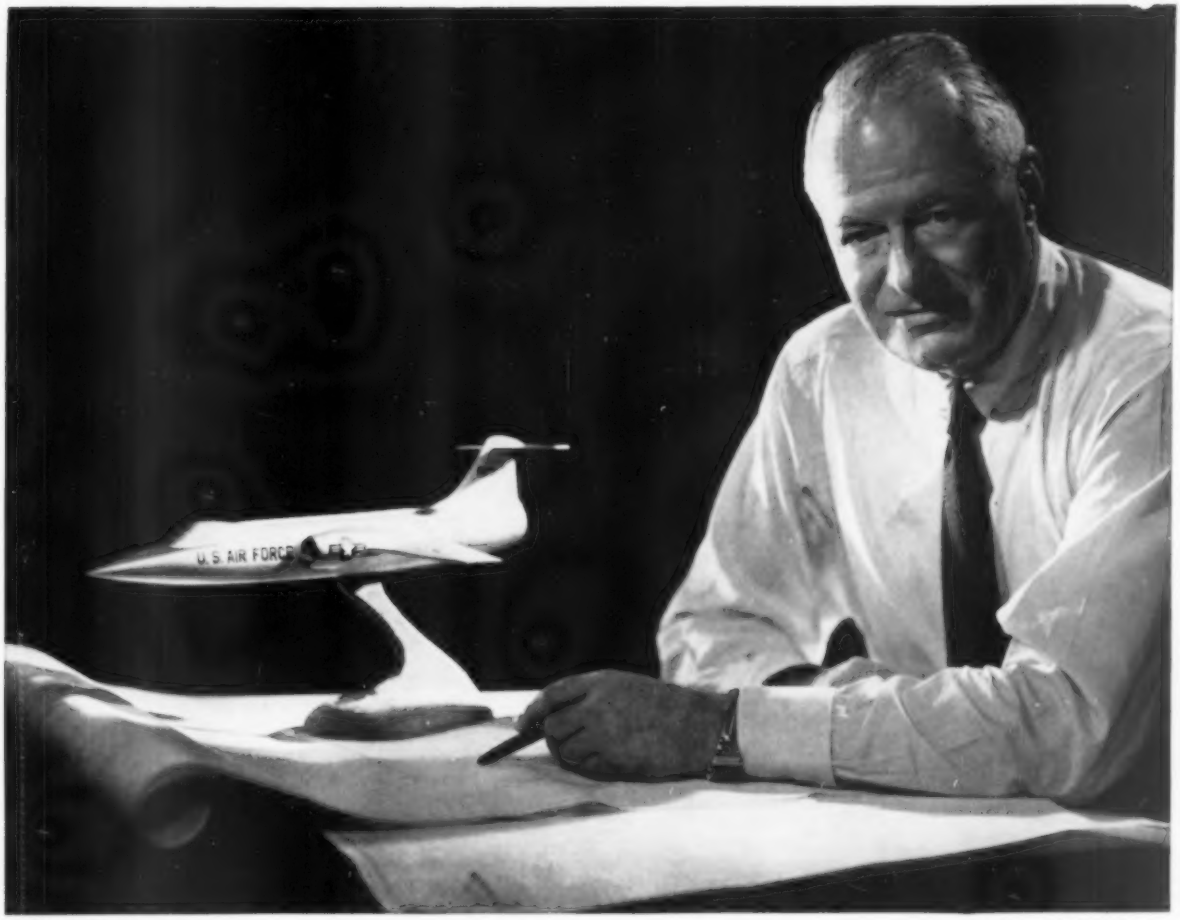

ROBERT E. GROSS

Portrait by Fabian Bachrach

34,500 Lockheed Employees Regularly Buy U.S. Savings Bonds

"We in the Lockheed Aircraft Corporation family are proud of our record of participation in the U.S. Treasury's Payroll Savings Plan.

"It is important . . . particularly in these times . . . for all Americans to support our nation's programs and policies in every way. I know of no better way than the regular purchase of Savings Bonds.

"Our records show Bond-buying employees are saving at the weekly rate of $165,000 . . . a yearly total of approximately $9,000,000.

"This thrift, practiced regularly, is a vital keystone in building family security. It also makes a significant contribution to stabilization of the purchasing power of the dollar and the prevention of inflation.

"Each of our new employees is given the opportunity to join his fellow workers in the Payroll Savings Plan. We feel this is an important step in insuring America's future security and prosperity."

ROBERT E. GROSS, ***Chief Executive Officer, Chairman of the Board, Lockheed Aircraft Corporation***

A simple person-to-person canvass that puts a Payroll Savings Application Blank in the hands of *every* employee is all you have to do to install the Payroll Savings Plan or build employee participation in your present plan. Your State Sales Director is ready to help you. Write today to Savings Bond Division, U.S. Treasury Department, Washington 25, D. C.

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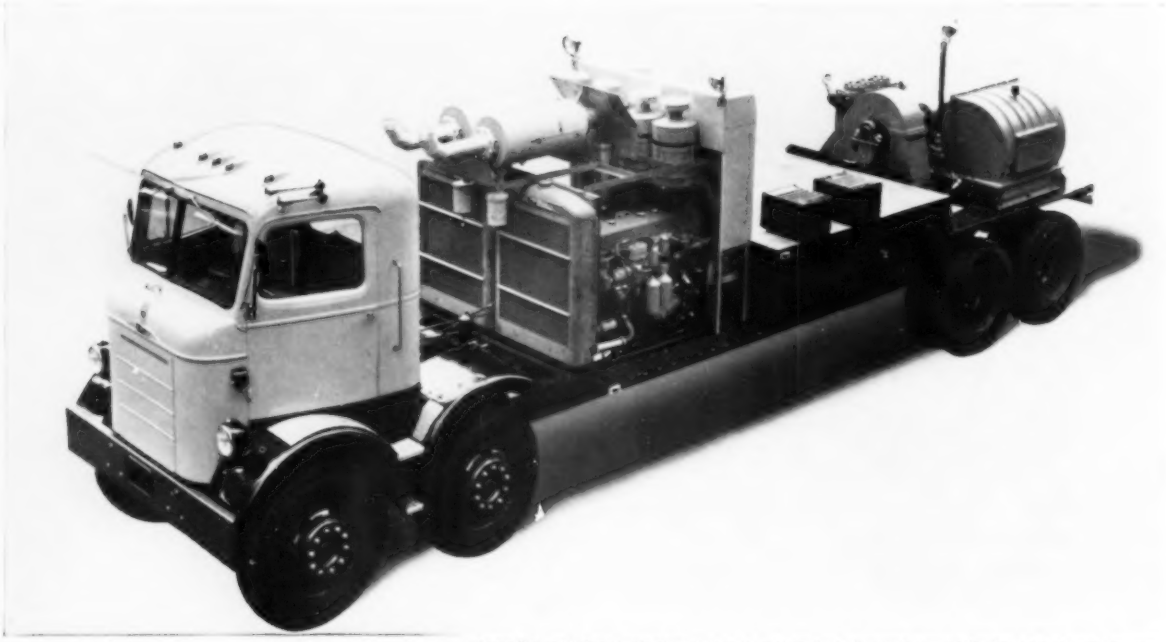
Compact Morse Hy-Vo® Drives transmit up to 5,000 HP—help make equipment truly portable!



Huge 50-mph fracturing truck has two diesels to furnish power for both truck and pumping unit. Slender, tough Hy-Vo Drives (2" pitch x 4" wide) compound diesels and operate pump; have 728-HP capacity.

Hy-Vo Drives take minimum shaft space, usually eliminate outboard bearings

As the search for oil sends drills deeper at greater speeds, the load on rig power transmission drives increases tremendously. Holding down the bulk and weight of the drives becomes critical—and that's where exclusive Morse Hy-Vo comes in.

Here's why:

Portability. Hy-Vo helps take the headaches out of moving day. Because it handles more HP per inch of width, the Hy-Vo Drive itself takes less space; that means you use the shortest possible shafts, usually *no* outboard bearings. And Hy-Vo's high speed capacity frequently permits the use of *smaller*, high-speed engines and motors.

High Capacity. Hy-Vo Drives transmit higher horsepower and speeds than any other chain drive. For example, a 2-inch pitch Hy-Vo Drive can handle 182 HP *per inch of width* at a mile a minute. No other chain in the world can match that.

Call Morse today!

For full information on Hy-Vo—and engineering help with *any* power transmission problem—call your local Morse distributor. You'll find him listed in the Yellow Pages of the phone book under "Power Transmission," or write: *MORSE CHAIN COMPANY, HOUSTON OR ODESSA, TEXAS; ITHACA, NEW YORK. Export Sales: Borg-Warner International, Chicago 3, Ill.*

FOR ROLLER CHAIN APPLICATIONS:

High Endurance Roller Chain eliminates premature chain failure—gives up to 400% greater fatigue life than conventional roller chain.

See your Morse distributor for details

IN POWER TRANSMISSION
THE TOUGH JOBS COME TO

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Movible Offshore Company's "Movible No. 2"

Movible Offshore Company's big new offshore drilling barge, the "Movible No. 2," is now drilling off the coast of Texas.

The mobile barge, built by the Ingalls Shipbuilding Corporation, was commissioned September 10. Its first drilling job is off Corpus Christi, Texas, for the Shell Oil Company, according to Bowman Thomas, president of Movible. Thomas said the new unit will be able to operate in deeper water than any fixed-deck unit yet constructed.

"Movible No. 2" will operate on the same principle as a floating dry dock. Vertical cylinders, however, have been substituted for the solid wing walls of a floating dry dock to reduce exposure to wave forces. The height from the base of the hull to the deck is 110 ft. The dimensions of the hull are 201 ft by 203 ft. The unit can drill as many as eight wells without moving the barge and can drill and workover wells on existing producing platforms.

Thomas was formerly chief petroleum engineer for Humble Oil & Refining Company, and in charge of the marine equipment division and the drilling equipment division. He was in charge of Humble's ship construction when Humble entered full scale operations in the Gulf and was assistant manager of production when he formed his own company in 1955.

In charge of "Movible No. 2's" first job off Corpus Christi is R. L. Meadows, superintendent. W. R. Choate, Jr. is head toolpusher, directly in charge of the barge. The company's rig No. 1 is at work off Grand Isle, Louisiana.

Union Producing Builds Mobile Platform

The Union Producing Company, Shreveport, Louisiana, recently awarded a contract to Todd Shipyards Corporation of Houston for a portable self-stabilizing, submersible, elevated deck drilling unit for service in the Gulf of Mexico.

The vessel, having characteristics generally similar to many of which are in operation or are being built for various owners, was designed by Friede and Goldman, Inc., Naval Architects and Marine Engineers, of New Orleans.

It has been designed to operate in the open sea in water 76 ft deep. It consists essentially of a slotted hull with an elevated drilling deck, supported by fixed columns. Lowering and raising of the hull is effected by ballasting. Stability during lowering and raising operations is maintained by four vertical stabilizing caissons, similar in principle to a large unit now being built for the Louisiana Offshore Drilling Company. The hull is of anti-scouring design, designed with sloped sides and ends.

This vessel will contain a 143-ft 1,000,000-lb cantilever derrick and all necessary drilling machinery and equipment for drilling to depths in excess of 20,000 ft, diesel generators, helicopter landing deck, and air-conditioned quarters.

Union's new unit will be 190 ft in length, with a beam of 160 ft, and have a hull depth of 13 ft. The slot dimensions are 32 by 36 ft.

British Petroleum's "Adma Enterprise"

First mobile drilling barge of its kind to be built in Europe, has left its fitting out berth at Audorf, on the Kiel Canal, Germany, on a 6800-mile tow to the Persian Gulf. It will be used to drill the first underwater deep test well undertaken jointly by The British Petroleum Company and Compagnie Francaise des Petroles in the waters off Abu Dhabi. The joint company, Abu Dhabi Marine Areas Ltd., holds a 65-year concession granted in 1953 by the Ruler of Abu Dhabi to investigate the underwater oil possibilities of

12,000 sq miles off the Trucial Coast. The barge is being towed by one tug by way of the Suez Canal. It is hoped to average four knots and the tow is expected to take about 2½ months. Its weight is 4200 tons and its draft about 10 ft 6 in.

Outfitting will be completed at Das Island, where a base has been built. The barge will then be towed 20 miles to its working position. There the legs will be lowered on to the sea bed and the barge elevated until it is 40 ft above high water level. Drilling is due to begin early next year.

The barge was built by Gutehoffnungshutte Sterkrade Aktiengesellschaft and designed by the DeLong Corporation of New York in conjunction with Abu Dhabi Marine Areas Ltd. for operating in water up to 80 ft deep. It is approximately 200 ft long by 100 ft wide and has a depth of 15 ft. It has four retractable legs each 10 ft in diameter by 165 ft long on which it is elevated or lowered as required by eight hydraulic jacks.

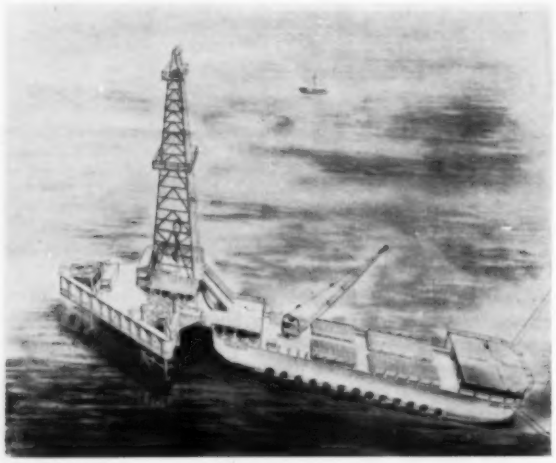
A drilling unit complete with all the necessary drive gear, pipe racks, drill pipe, etc. capable of drilling a hole up to 15,000 ft deep is installed on the barge. This unit is powered by four 400 hp engines. The 140 ft high derrick is mounted on a 30 by 30 ft base and is capable of a maximum pull of 1,100,000 lb.

"Blue Water No. 1"

Blue Water Drilling Corporation, New Orleans, Louisiana, has commissioned the "No. 1 Blue Water" at Ingalls Shipbuilding Corporation yards in Pascagoula, Mississippi.

The mobile platform's construction permits six wells to be drilled without moving the barge. Overall dimensions are: Length, 242 ft; width, 202 ft; height of working level above the barge base line, 100 ft; distance from the barge to top of mast, 268 ft. It is designed to operate in water depths up to 70 ft. The unit is similar to other "bottle-shaped" four-legged structures now in operation. It obtains its buoyancy for moving from a grid pattern of its cylindrical members.

The platform has air-conditioned crew quarters for 50 men in a single steel building, topped by a helicopter landing deck.



Aramco's Persian Gulf Job-Hopper

Arabian American Oil Company of New York has placed orders for a new type "miniature" mobile platform, designed specifically for use with a tender, for drilling in the Persian Gulf off Saudi Arabia. When completed at yards in Vicksburg, Mississippi, the unit will be towed across the Atlantic.

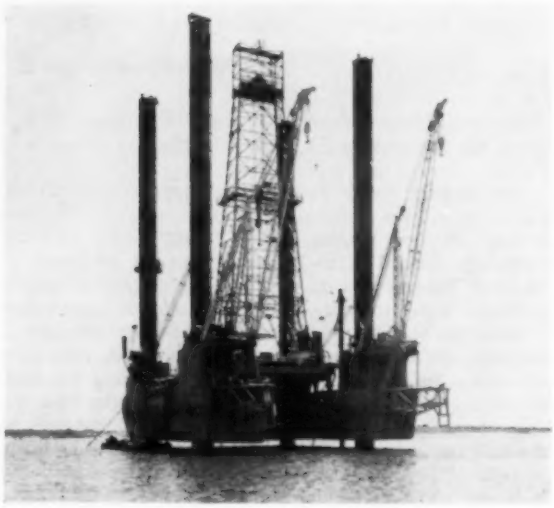
Builder of the platform, R. G. LeTourneau, Inc., has promised delivery in five months.

Officials of the building firm have indicated that the cost of the small tripod unit is less than $750,000, considerably less than most offshore platforms.

Chief difference in operation of the new junior platform and the self-contained units is that virtually all supplies and crew accommodations will be contained on a tender. It will be triangular in shape with only three lattice-work legs and will be raised and lowered by powerful electric motors geared directly to steel cogs running the length of each leg.

Electric power for operating the legs will be supplied by diesel generators located aboard the platform. Power for the drilling equipment, however, will be supplied by generator sets aboard the tender.

Dimensions of the platform are: Length overall 92 ft; width overall 88 ft; depth of hull 10 ft; length of spuds 103 ft; diameter of spud tanks, 18 ft and 4 in.; height of spud tanks, 10 ft; total load during elevation, 112½ tons; and maximum load in fixed position, 350 tons.



Glasscock Drilling's "Mr. Gus II"

"Mr. Gus II" is now on its first drilling assignment. The unit, designed to drill in water 150 ft deep, is making hole for the CATC group (Continental, Tidewater Associated, Cities Service and Atlantic) in 77-ft water 25 miles from shore in Block 48, Grand Isle area of Louisiana.

Built by the Bethlehem Shipyard in Beaumont and owned by the Glasscock Drilling Company, Gus II is power potent. Its main power plant consists of five diesel-electric skid-mounted units, each rated at 1000 hp and each consisting of two 500 kw d-c generators, driven by four diesel engines.

Drilling equipment on "Mr. Gus II" consists principally of a drawworks with a combined capacity for hoisting service of 2700 hp. The three pumps have a combined capacity for continuous duty service of 1200 hp. The independent rotary table is also driven with an individual d-c electric motor as well as the coring reel.

To secure itself to the Gulf floor, Mr. Gus II operates in a unique manner. A mat, or lower hull, is attached to the four giant columns. This mat lowers to the Gulf floor. Inside the columns are pilings which in turn are hammered into solid formations deep into the floor.

Then, through a hydraulic system, the top hull jacks itself up on the main columns until it is safely out of reach of high Gulf waves.

It is the only mobile unit now operating that is designed to drill in water 150 ft deep.

One of the Macks operated by H. L. Choate Trucking Company—an oil-field hauler from Alice, Texas. President Choate says...

"In rough oil-field operations... there's no substitute for a MACK"

"Thirty years in the oil fields have taught me that Macks are the only real truck buy. Their thrifty, steady work habits quickly make up for their higher initial price... they pile up year after year of money-making service long after so-called 'bargain' trucks are on the scrap heap. I've made my last experiment with buying cheaper trucks. For my money, there's no substitute for a Mack."

That's the way Mr. Choate, president of Choate Trucking, feels about Macks. And his oil-field operation certainly puts trucks to the test. Loads vary from 25,000 to 135,000 pounds. Hauling is often through swamps, heavy sand, gumbo mud, and over mountainous terrain. Yet Choate's Macks average 5 to 8 mpg of diesel fuel... running up 50,000 miles a year and plenty of winch time... with a minimum of down time.

Here's just one more example showing why it pays to operate the best. Your local Mack representative will gladly show you other on-the-job reports proving the same point. Mack Trucks, Inc., Plainfield, New Jersey. In Canada: Mack Trucks of Canada, Ltd.

MACK
first name for
TRUCKS

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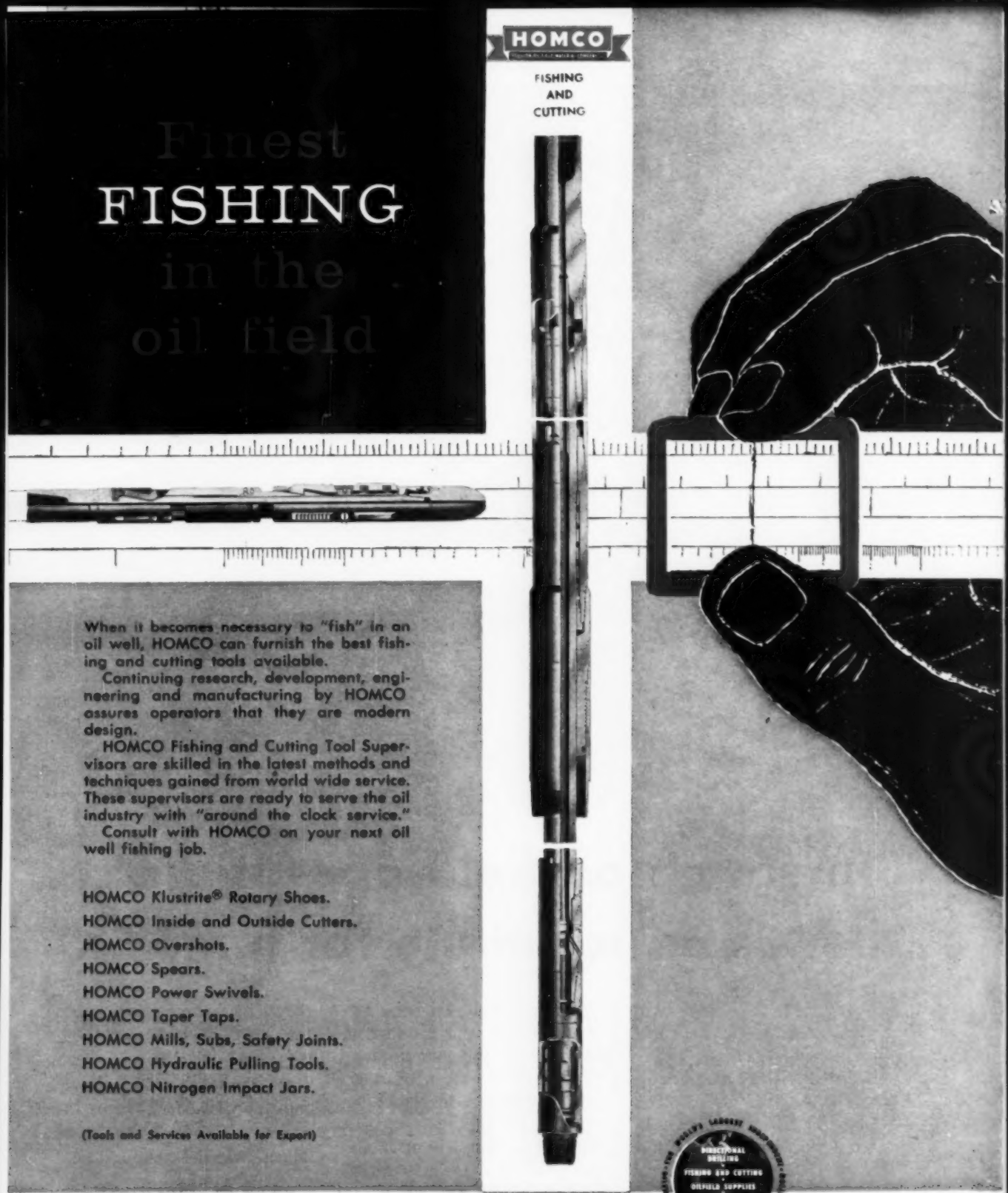
Finest FISHING in the oil field

HOMCO

FISHING AND CUTTING



When it becomes necessary to "fish" in an oil well, HOMCO can furnish the best fishing and cutting tools available.

Continuing research, development, engineering and manufacturing by HOMCO assures operators that they are modern design.

HOMCO Fishing and Cutting Tool Supervisors are skilled in the latest methods and techniques gained from world wide service. These supervisors are ready to serve the oil industry with "around the clock service."

Consult with HOMCO on your next oil well fishing job.

HOMCO Klustrite® Rotary Shoes.
HOMCO Inside and Outside Cutters.
HOMCO Overshots.
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HOMCO Power Swivels.
HOMCO Taper Taps.
HOMCO Mills, Subs, Safety Joints.
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Fifteen "rig-tested". . .

Drilling IDEAS at Work

Off-Substructure Walkways

● What could be more practical than these steel walkways? By routing all rig lines under these steel mesh passageways, a real safety factor is added to the convenience purpose of this idea.

The sections were easily constructed by welding the mesh to sucker rod frames 20 ft in length. Using 20 ft joints of pipe for the supply lines, fitted with unions for quick hook-up, all connections break at end of walkways — for added neatness and faster rig up. For ease of handling, six carrying handles have been welded to each section.

This contractor has all off-substructure lines under the walkways. Two of these lines are for supply and return water line. Two other 2-in. lines are supply and return steam lines. Also under the walkway are four 1-in. lines: One for fuel, one the charged line to BOP controls, one for BOP remote control, and a relief line. In transit, the walkways are stacked flat on drill pipe loads.

One Load for Water and Fuel Tanks

● Loading and erecting the fuel and water tank as one unit, as did one drilling contractor, saved a needless truck load and fuel tank stands.

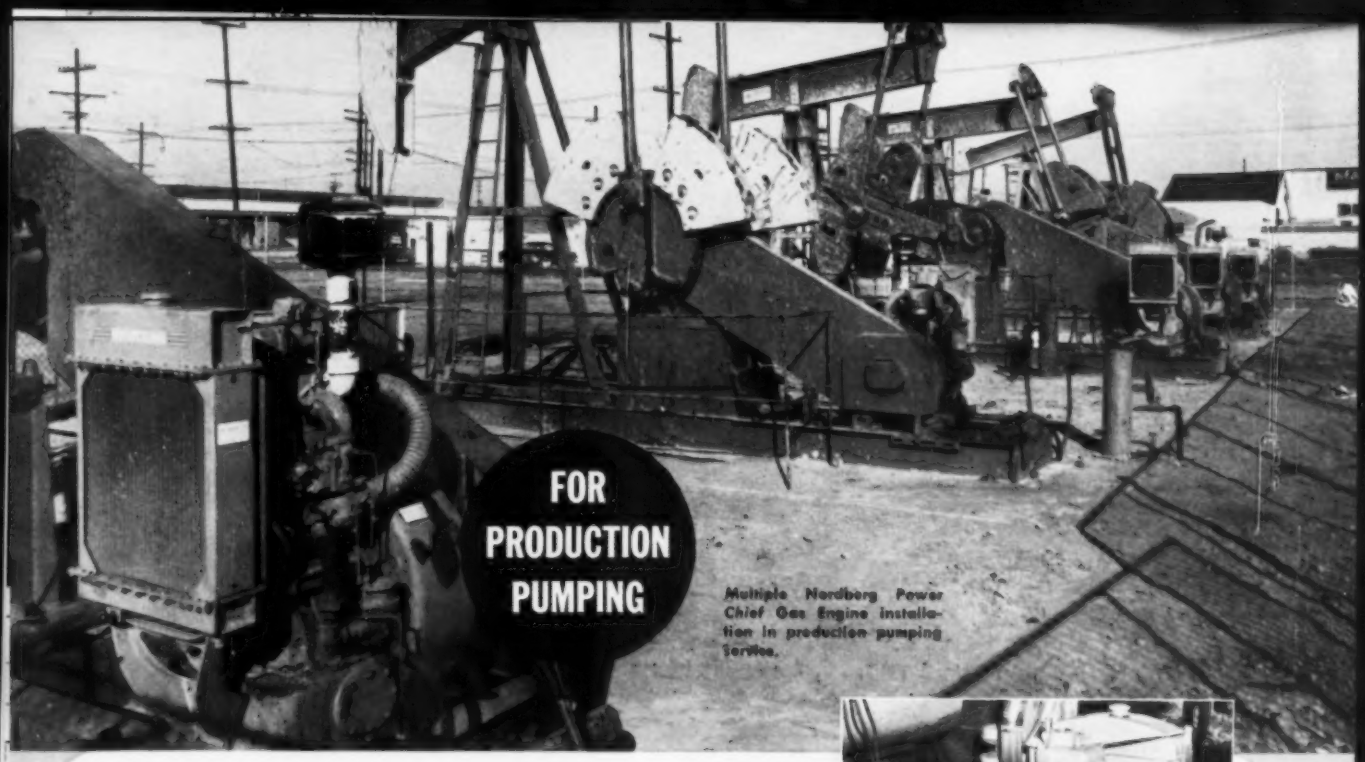
The rectangular water tank was designed so that the fuel tank could be lowered into it and raised from it by two gin pole trucks. Each end of the fuel tank is equipped with a self-leveling winch-line so that as the tank is raised, supports attached to the side of the water tank may be swung into position to form a platform. The unit is moved, and may be lowered and raised, with fuel in the tank. Notice the platform, ladder and collapsible guard rail for safe tank gaging.

Crown Stand and Spool Cradle Combination

● There's one less item to haul from location to location on this rig by combining the crown stand, used when laying down a jackknife drilling mast, and the drilling line spool cradle.

The combination was made by welding an 8-in. piece of drill pipe on each leg of the crown stand, as shown here. A section of drill pipe is used as the spool axle and is lifted into place.

Judging by the snow on the ground, the contractor must have found this to be a "real cool" idea.



Multiple Nordberg Power Chief Gas Engine installation in production pumping service.

NORDBERG POWER CHIEF® ENGINES

are your BEST BUY!

In the low cost medium speed field, *Power Chief* engines give you all the design, construction and fine quality that has made Nordberg engines famous throughout the world for over 50 years. *Power Chief* engines are so simple in design that they can be maintained, in the field, with only a few ordinary hand tools.

Here are some of the features that make *Power Chief* engines your *Best Buy:*

Removable wet cylinder liners • Valves in head • Replaceable valve guides • Special alloy inserted exhaust seats • Positive full pressure lubrication • Internal ventilation bars entry of dirt • Crankcase and all other vital parts fully sealed • Oil heat exchangers maintain proper internal temperatures at all loads • Safety approved, enclosed heavy flywheel smooths out fluctuating loads • Fram oil filters • Vortox oil bath air cleaners • Wico & Bosch magnetos • Twin Disc clutches • Murphy safety shut-down devices. (No extra added costs for these when you buy.)

Power Chief Gas Engines in 1 and 2-cylinder models deliver up to 36 hp maximum rating. *Power Chief* Diesel Generator Sets produce 6 to 30 kw for continuous service. All are available with special vibration-proof mounting. NORDBERG MFG. CO., Milwaukee, Wisconsin

Typical rig-mounted Power Chief Diesel Generator Set for lighting service.

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Write for Bulletin describing Nordberg *Power Chief* Oil Field Engines.

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DIESEL and GAS ENGINES

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CORNELISON ENGINE MAINTENANCE CO., INC., Seminole, Oklahoma

ROGERS DIESEL ENGINEERING CO., New Orleans, La.

Protection for Rotary Hose

● Ay, there's a rub. And it's usually in the rotary hose.

One contractor has eliminated excessive wear to this expensive piece of equipment by encasing strategic parts in discarded rubber tires. Before lacing the tire onto the hose, remove the steel rim and cut the walls to the tread. Holes are punched in each section and wire is used to clamp them to the hose. The one here, by the way, is a 6.70 by 15-in.

Power Driven Storage Reel

● A new idea in storage reels for wire rope has been found exceptionally helpful in spooling line and assisting cutoff operations. The reel is mounted in the substructure and is provided with a sprocket welded on the side of the reel. Reel is driven by a ½-hp electric motor. The motor used is a reversible type which can provide power in spooling as well as un-spooling the wire line. Procedure used is to run new line on to the storage reel from the warehouse spool. In stringing up, motor is reversed and power drive is utilized to assist in slipping lines. On periodic cutoff operations, power on the spool is again used to aid in slipping the lines.

A slack chain drive is used between motor and spool.

Buying globe stop valves?

REDUCE WEAR, PRESSURE DROP

with Edward "streamlined flow"!

IN AN ORDINARY globe valve, sharp turns cause wear-producing turbulence and excessive pressure drop. Edward forged steel inclined stem valves with streamlined flow cut turbulence, reduce pressure drop as much as 50%. Flow is eased through the valve with no sharp changes of direction. Wear on body, disk and seat is much less, especially in higher pressure-temperature applications. Whether for steam, water, oil, gas or chemical services, Edward valves are built for long, trouble-free life. To cut maintenance costs and replacement inventories, always specify Rockwell-Built Edward Valves. They're the choice of operators all over America.

JUST CHECK THESE EXTRA EDWARD FEATURES:

- **Forged steel body and bonnet!**
- **Stainless steel EValloy stem resists corrosion!**
- **Hardened EValloy stainless steel seat and disk!**
- **Interchangeable parts cut inventories!**
- **Swivel disk prevents seat galling!**
- **Positive backseat permits packing under pressure!**
- **Swing gland bolts make repacking easy!**

Rockwell-built Edward forged steel inclined stem valve with *streamlined flow* . . . sizes from ¼" to 2". Ratings to 1500 lbs at 850 F, 3600 lbs W.O.G.

OILFIELD SUPPLIERS: Contact your nearest Edward oilfield representative—or write us direct—for prices and information on stocking Edward Valves. Ever-growing preference for Rockwell-built Edward Valves assures you a steady profit.

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Let Merla calculate your next installation . . .

Contact your nearest Merla Representative and let him calculate your next gas lift installation with either conventional outside mounted or wire line retrievable equipment.

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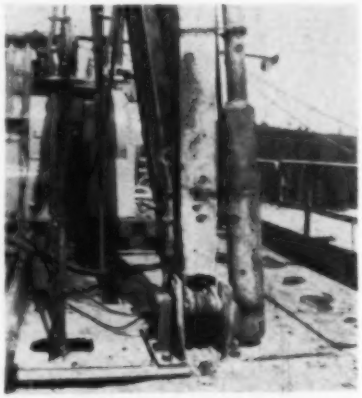
Spooling, Lowering Wire Line Made Easy

● Spooling of drilling line has always presented a challenge to the ingenuity of the man on the rig – and the solutions to this problem are as numerous as there are sample sacks in the mud house.

One of the most effective, shown here, is really two innovations in one.

First, the spool is permitted to roll free by the use of a hinged cradle attached to the lower part of the substructure skid. After the line has been spooled and the rig is readied for a move, the spool is swung to the ground and the axle is removed for loading.

Second unique feature of this mechanism is that the line may be spooled without physical effort by throwing a pleated rope on the drum (at the left of the wire line spool) and the cathead, turning the spool in V-belt fashion.



Keep the Overshot Handy

● It seems to be a problem to have an overshot ready for running "out from under foot," and yet easily accessible when needed. One contractor makes it a practice to make up the overshot by hand into a pickup sub, then tying it to the derrick leg with a light chain. The overshot is then always just a step away.

BREWSTER

TRAVELING BLOCKS AND HOOK BLOCKS

OVER 45 YEARS EXPERIENCE

MODEL HT-100 HOOK BLOCK
WITH TWIN EAR ELEVATOR HOOK

The Best Blocks

FOR TOP-TO-BOTTOM SERVICE IN MAST OR DERRICK

Whatever your drilling requirement – whatever the type mast or derrick – there is a matched Brewster Traveling or Hook block that will speed up your round trip time. Built for years of rugged service, Brewster blocks have big oversized parts that assure an extra margin of safety to handle shock or heavy emergency loads. They are streamlined and balanced with low center of gravity for straight line travel.

The product of over thirty years of continuous improvement and development, Brewster blocks are now available in a range of capacity from 50 to 500 tons.

Ask your supply house for Brewster traveling blocks, hook blocks and matching crown blocks – or write direct.

Outstanding Features

TRAVELING BLOCKS

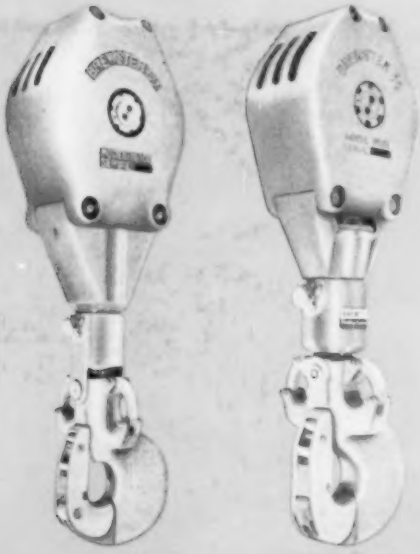
90 to 500 Tons

TIMKEN TAPERED ROLLER BEARINGS eliminate side thrust on sheave hubs.

CENTER PIN made of heat-treated alloy steel – rifle drilled holes for lubricating individual bearings.

SHEAVES made of alloy steel, accurately machined to A.P.I. specifications – grooves are flame-hardened.

ROUNDED CORNERS, COUNTER-SUNK BOLTS permit block to travel smoothly without danger of fouling.



HOOK BLOCKS

50 to 100 Tons

Unitized for High-speed Mast Service. Brewster Hook Blocks are unitized assemblies combining the block, spring-loaded link adapter and hook in one short unit. The added headroom gained by this design permits faster operation in masts or short derricks as the pipe may be hoisted safely at full speed to the top of run. Free swiveling on roller bearings, the hook can be locked in any one of eight positions. The improved swivel lock has two ears to permit easy operation by reach rod from the derrick floor. Sheaves are mounted on double row Timken tapered roller bearings. The hook is made from tough Chrome-Nickel-Moly steel.

CROWN BLOCKS

100 to 500 Tons

The practical rugged design of Brewster Crown Blocks has made them first choice with many contractors. Sheaves are cast of alloy steel, grooves machined to A.P.I. specifications with flanges hardened to reduce wear. Each sheave is mounted on double-row tapered roller bearings and is individually lubricated.

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Shreveport, Louisiana

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ORBIT FORGED STEEL VALVES

for your
6,000 and 10,000 lbs. test
CHRISTMAS TREES

Orbit designs valves to meet all the special requirements of Christmas Trees for high pressure production operations. Built for top performance under most rugged conditions, these high pressure Orbit valves' maximum operating ease and low-cost maintenance make ORBIT your best buy. Available through your favorite Well Head Manufacturer.

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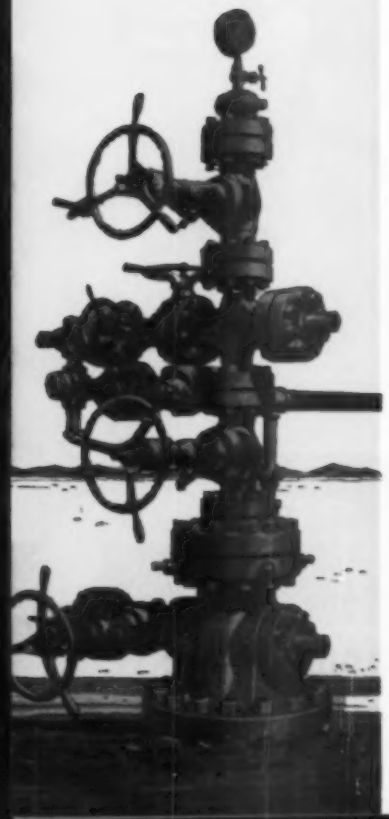

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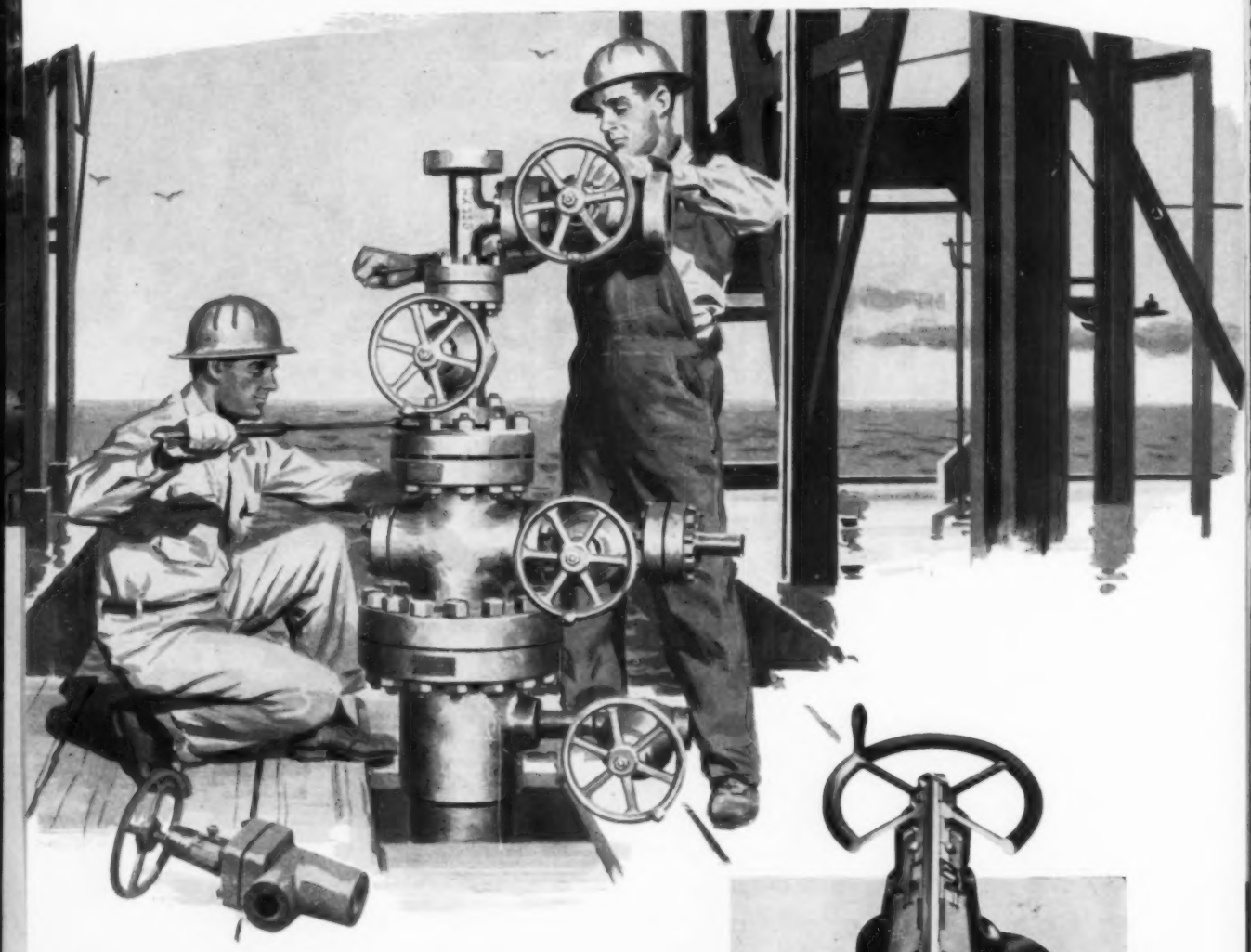

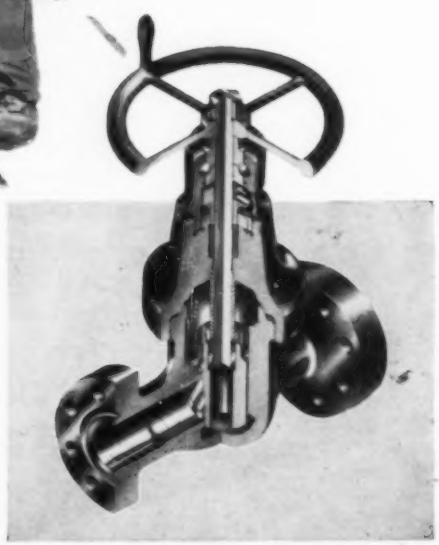

BIW non-lubricated gate valves

You know that you can install them and forget them. More than 35,000 BIW Valves in the field prove that. The design of the valve is so simple that there is nothing to get out of kilter, nothing to require attention. Best of all, the human element can be almost forgotten, for the BIW Valve does not require lubrication ever. The tight metal-to-metal seal is permanent and is always ready to seal tightly.

The BIW Valve is as easy to operate as it is positive. Only 25 foot-pounds of torque are required to open or close the 2½ in., 10,000 lb test valve against 5,000 psi pressure. And when it's closed you know it will hold.

ALCO specialists will show you the complete BIW Christmas tree with proved BIW Non-Lubricated Gate Valves.

Write or call Petroleum Industry Equipment Division, Department BV-1, Bank of the Southwest Building, Houston 2, Texas.

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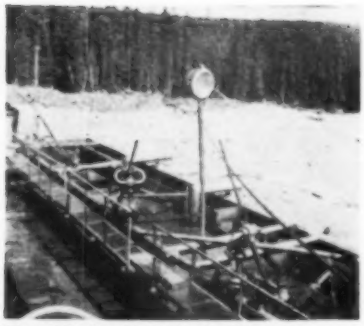


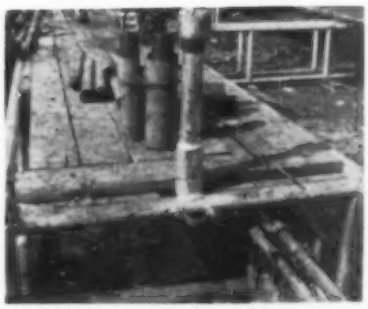
Floodlight for Mud Pit Area

● Make one light serve the purpose of 10.

One floodlight (500 watt) can very effectively do the work of an entire string of lights in the mud pit area. All too often this strategic area is either under lighted or cluttered with lines and light poles. By placing one large electric lamp to illuminate the entire area, maintenance is cut to a minimum, safety is maintained, and total electrical power conserved.

Discarded Tool Joint Finds Use

● By welding a box-end tool joint from discarded drill pipe into the end of the catwalk, several operations have been eased. By making up a short pin-end piece of drill pipe into the box, it becomes useful when laying down drill pipe or whenever it is necessary to snub



a snatch block to it for pulling objects away from the rig floor and down the catwalk. By mounting the joint flush with the catwalk floor, it does not interfere with moving.

A Tool Rack — For All Tools

● A tool rack that will accommodate all tools used on the rig floor will always find ready acceptance. This sturdy

triangular rack, mounted on a skid-type base, is a good example. There are plenty of hooks, slots and holes for nearly any tool — from tong heads to grease gun. A lifting hook on top permits the rack to be easily moved.

Guard Saves Pump Valve Stem

● This shear release valve stem guard on the mud pump protects the stem from being lost or damaged. This guard on the relief valve, as seen in the picture, is never removed from the pump. After the valve shears, it can be neatly dropped back in place.

The guard is constructed of a cup made of pipe, hinged onto a welded arm. The chain is for added safety.

FABRICATED STAR BITS

The Fabricated Star Bit shown here has been designed especially for big hole drilling in hard formations. Far more efficient than the old style spudding bit and the big hole paddle-type bit, these Star Bits are custom-engineered to suit the particular hole size and the capacity of the drilling machine used.

Spang Fabricated Star Bits save labor and money. They can be quickly dressed to gauge, and speedily ready for drilling, by hard surfacing the cutting edge.

For drilling large diameter holes profitably

Here is a Fabricated Star Bit that has been successfully proven on numerous large hole projects. It is available in a wide range of diameters, and weights . . . the lengths in which they can be furnished are directly related to their overall weight.

Complete details and literature on request.

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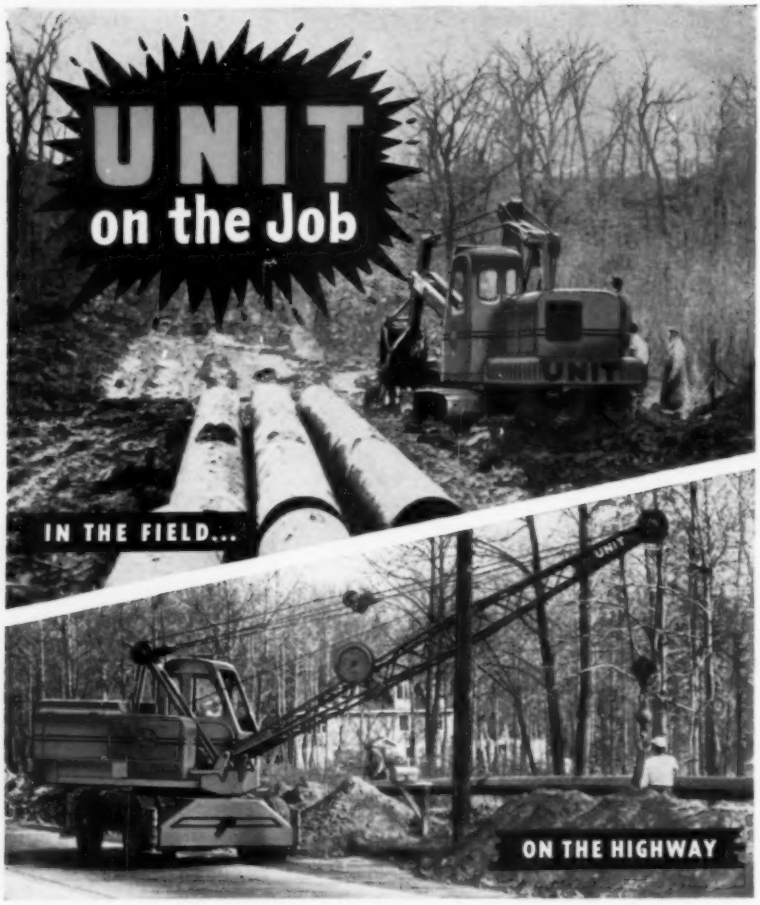

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In the field where the going is tough, UNIT TRENCHOES have the traction and power for continuous ditching to meet pipeline schedules. For laying pipeline along the right-of-way, where the going is smooth, the self-propelled mobile UNIT offers road travel speed, plus accurate lift and swing control. Designed for speed and stability, UNIT crawler and mobile equipment are built to meet every trenching and handling job required in pipeline construction work.

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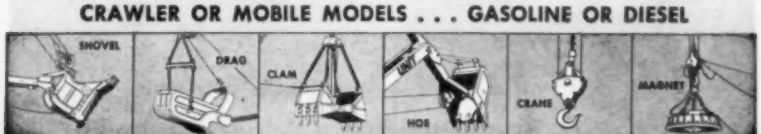
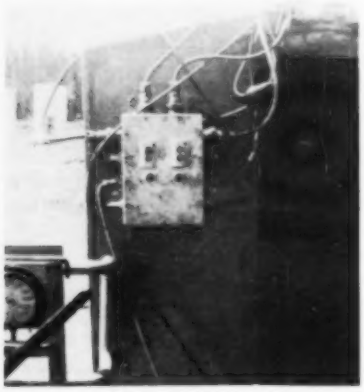


All Models Convertible to ALL Attachments!

A Light Idea!

● Centralizing all electrical controls on the rig in one panel box on the front of the doghouse has definite advantages. This contractor noticed great



savings in bulbs when this control was placed near the driller's station.

Main plugs for all rig lights, shale shakers, and auxiliary equipment motors feed into this panel. Two main power supply lines — one a 110-v line and one a 220-v line, are run from the power plant to this main box. All rig lights are operated by switches on the bottom of the panel. The arrangement makes for quick rigging of lights and electrical equipment, and it looks neater — and is definitely safer.

Lifting Boom for Onshore Rigs

● Offshore rigs with their ever-useful lifting cranes are not to be envied by a drilling contractor with this boom.

The boom, with a 30-ft reach, has

proved itself useful in handling mudlines, oil barrels and small equipment out of reach of the regular catline. The boom is pinned in the derrick and the end suspended by a cable anchored below the crown.

Blind Valve on Mud Section

● Advantages in this blind valve can be easily seen. By welding a blind valve into the suction line of the main mud pump, as shown here, and by opening a 4-in. valve placed ahead of it from the water line, water can be used for jetting mud tanks, cellar, displacing hole and to meet the many other demands for water under high pressure.

This has also proved a most effective method of washing highly corrosive mud additives from mud pumps and the entire mud system before tearing down a rig, or making abrupt mud program changes.

Blueprint Tube — Where Needed

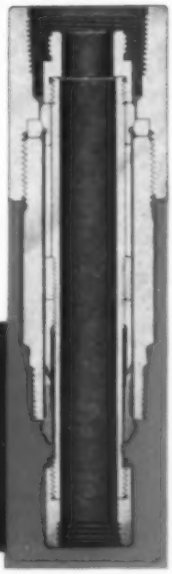
● Can't find your derrick and substructure blueprints? Perhaps they would have been easily found, had you built a waterproof compartment as did one drilling contractor. A 30-in. piece of 4-in. line pipe, threaded on one end, was welded into the derrick leg. A cap screw was placed on top and the other end welded closed.

It has proved a perfect place to store rig plans, blueprints, BOP schematic and other information needed when rigging up.

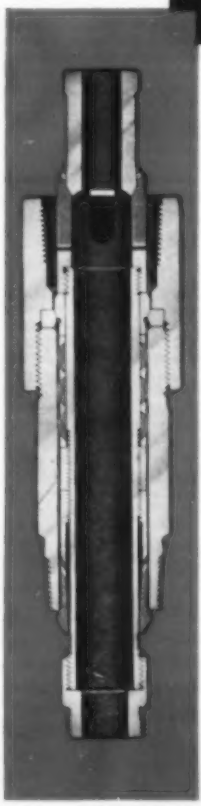
Wireline servicing made easy with a

PACIFIC PERMANENT COMPLETION PUMP HOLD DOWN

The Pacific Permanent Completion Hold-Down is designed with maximum opening through the shoe to permit use of Permanent Completion Tools through it. The sealing arrangement has replaceable Stainless Steel Sealing Ring with a reversible Stainless Steel Sealing Ring Seat and can be used on any type A.P.I. rod pump.



Undersize rings can also be furnished to allow pumps to be run through a Permanent Completion "S" Nipple and seated in the pump shoe.



If at any time the Stainless Sealing Ring Seat, which is part of the Tubing Assembly, should become damaged or leak, an effective seal can be obtained without pulling tubing. The Rod Assembly is engineered and designed so that by replacing the Spacer Ring on the Hold-Down Lock Body with three Ring Type Seating Cups, the seal is transferred to the Seat Support Nipple with the Sealing Ring and Sealing Ring Seat serving as a No-Go ring and supporting the load.

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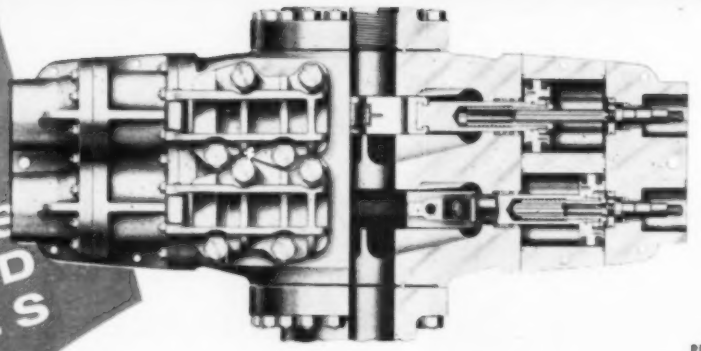
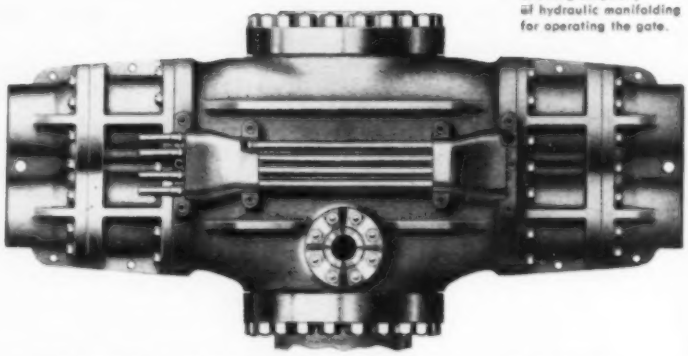


CUTAWAY VIEW
Showing direct hydraulic drive and self-draining ram compartments.



REAR VIEW
Showing simplicity of hydraulic manifolding for operating the gate.

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SOUNDS ACADEMIC

— and maybe it is. But the point we make is this: — Feature by feature, no other cellar control gate incorporates so many advanced features as do SHAFFER *Gates. So why settle for less when you can get all of these unique advancements by specifying* SHAFFER*?*

Shaffer Gives You
UNMATCHED CONVENIENCE!

Rams must be changed frequently to fit varying pipe sizes as wells are drilled. With Shaffer Hydraulic Gates there is no need to dismantle the unit to change rams. You simply unbolt patented *side-opening* doors . . . swing them open . . . change rams . . . and bolt the doors shut again. Closing the doors automatically aligns the rams within the gate. And complete ram changes can be made with equal convenience whether the pipe is in the hole—or out!

Shaffer Gives You
GREATER VERSATILITY!

For simplified inventory and maintenance, you can standardize on Shaffer Gates—yet maintain maximum versatility to meet varying field requirements. Shaffer provides a choice of either Single or Double Hydraulic Gates with the same unique design and operating advantages. Also, in each type you have a choice of *Rising* Locking Shafts (where quick indication of ram position is desired) or *Non-Rising* Locking Shafts (where maximum compactness is desired). Rams and most other parts are interchangeable, size for size!

Shaffer Gives You
SPACE-SAVING COMPACTNESS!

Cellar equipment that is bulky can take a high toll in greater rig costs, larger cellars, clumsy hook-ups. But Shaffer Gates are unusually compact in *all three* dimensions—height, width, and length. Furthermore, no extra space need be allowed above gate—or at ends—for servicing rams. **Result**—even in sizes as large as 13⅝" (12" Series 900) the Double Gate has a *total* height of only 30" . . . the Single Gate only 18½". *No extra space need be allowed above or at the ends for ram changes.*

Shaffer Gives You
OTHER ADVANTAGES!

Still other Shaffer advantages that save time, boost efficiency and assure better performance include **Self-Draining Compartment Bottoms** with rams traveling on high guide ribs where no detrimental mud and sand can accumulate . . . **Simple, Direct Drive** with operating pistons *directly behind* rams for maximum power, fewer parts, positive simplicity . . . **Completely Enclosed Design** with no exposed moving parts to jam or corrode . . . and many other unique features.

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REMEMBER—

Shaffer also manufactures a complete line of *Mechanical* Cellar Control Gates—both Single and Double Types—for those desiring this type of equipment. Ram Blocks and Ram Rubbers are interchangeable, size for size, with those in Shaffer Hydraulic Gates, assuring further savings where both types of gates are used.

See your nearest Shaffer representative for complete details—or write direct!

Send for your free copy of the latest Shaffer Catalog!

Shaffer products are described in your Composite Catalog!

EXPLORATION ACTIVITIES

PANAMA

★ Cataract Mining Corporation announced a further step in the development of the 5,000,000 acres of oil and gas leases which it owns and controls in the Republic of Panama. In line with this, the United Fruit Company announced that it had acquired the rights to explore for petroleum over an area of 1,000,000 acres in the Province of Chiriqui in the Republic of Panama. The concession referred to is one granted to Cataract Mining Corporation, which was dealt to Time Petroleo, S. A., a subsidiary of Time Petroleum Company, of Wichita, Kansas, which in turn conducted the negotiations with United Fruit Company. In addition to the 1,000,000 acres dealt to United Fruit Company, Cataract owns and operates oil and gas concessions in excess of 4,000,000 acres in various provinces of Panama, including an additional 1,000,000 acres in the Province of Chiriqui.

SAHARA DESERT

★ Interest in oil exploration in the Sahara is mounting, with Cities Service Company the first American company to take formal steps to enter the area. Cities Service has signed an exploration agreement with two French oil companies and the group is applying for exploration permits. A company to operate such a concession would be set up only if oil is found, officials say. Interest in the desert is running high because of recent important discoveries made by two Royal Dutch Shell groups and three French companies. Since 1952, the five have drilled more than 50 holes. American companies mentioned interested in the area are Sinclair, Texas-Gulf Producing, and Standard of California.

OKLAHOMA

★ British American Oil Producing Company has set a new depth record for production in the state at its No. 1 Krieger in Stephens County. Well, in the Knox deep district, is making dry gas from the Oil Creek sand. This zone was perforated at 16,440-448 ft and recovered 3650 ft of mud; an additional zone was perforated at 16,526-546 ft and both intervals were tested together. On this test, the No. 1 Krieger flowed an estimated 7,600,000 cu ft of gas through a ¼-in. choke, then made 4,100,000 cu ft per day on 3/16-in. choke; there was no condensate in the separator. Flow pressure increased from 7530 to 7600 psi, with shutin bottom-hole pressure of 9500 psi; hydrostatic pressure was 11,405 psi. Biersen & Cochran has contract on the deep producer that had been drilled to 17,484 ft, then plugged back to 16,640 ft. Gulf and Ohio Oil are supporting the test. There were commercial gas shows in the Viola lime at 13,850-965 ft and commercial gas-condensate shows in the Second and Third Bromide sands, regular Knox deep pays.

★ Ambassador Oil Corporation has a new discovery apparent at its rank wildcat in Tillman County. The No. 1 Oaks, northwest of the North Trimue pool, flowed 180 bbl of oil per day on 14/64-in. choke from perforations in 5½-in. casing at 5028-47 ft. Three drillstem tests made oil in the Strawn conglomerate at depths from 4791 to 5047 ft. A discovery allowable of 150 bbl per day has been permitted for 27 days.

★ Indications of a gas discovery was reported by Cities Service at its Murdock No. 1 test on its 77,440-acre North Guymon Block in Texas County. On a 25-min drillstem test in the Morrow "L" sandstone between 6060 and 6101 ft, 8,080,000 cu ft of gas was gaged with a spray of condensate. Initial and final flowing pressures were reported at 1700 psi, with shut-in bottom-hole pressure gaged at 1750 psi in 20 minutes. Nearest Morrow sandstone production is in the Camrick field, 18 miles to the southeast of the Murdock discovery. The new discovery is approximately 10 miles northeast of Guymon, and is spotted in the center NE SW Sec. 10-4N-15E.

CALIFORNIA

★ Shell Oil Company commenced operation recently for the drilling of Shell-Richfield-GP No. 1, a wildcat test to be located on the west side of the city of Santa Paula approximately 1500 ft westerly from Palm Avenue and 1000 ft north of Main Street on the Blanchard property.

★ An important step-out well was recently completed by Union Oil Company of California one mile south of Stenderup production in the Arvin area, Kern County. The well, Houchin 53-27, was gaged initially flowing 1377 bbl per day of 34.3 deg oil from the Santa Margarita formation at a depth of 8260 ft.

MISSISSIPPI

★ Rimrock Tidelands, Inc., has completed a new oil discovery well in the McKittrick sand to open a new field in Wilkinson County. The well, the G. I. Crook No. 1, is located on Sec. 33, 4N, 1E, on a 780-acre block. Rimrock has three direct offset locations to the discovery well and Pan American Petroleum Corporation has one. Perforated at 6612½-16½ ft, the well is flowing at 96 bbl of 36 deg oil a day on a 6/64-in. choke with 440 psi tubing pressure and with 350 psi casing pressure.

MONTANA

★ A farmout on 86,000 acres in Blaine County has been taken by Porter Oil Corporation, Billings, with the agreement to drill 10 exploration tests. The farmout is from Tidewater Oil Company. First location is the No. 1 Holman Ranch, in the Cherry Ridge area. For drilling the wells, Porter will get half-interest in the acreage.

TEXAS

★ Woodley Petroleum Company and The Moran Corporation have completed their jointly owned Fred Hendrix No. 1 well in the A. Del Rios Survey of Madison County. On 24-hr test the well flowed 211 bbl of 35-36 deg oil through 14/64-in. choke through perforations from 8824-32 ft and 8836-44 ft in the Sub-Clarksville formation, with estimated gas-oil ratio of 1000 to 1. This well is approximately three miles from the nearest production.

★ Star Oil Company, Inc., of Graham, Texas, has completed its No. 1 Earl Spring as an Ellenburger lime oil discovery 4½ miles south of Ringgold in Montague County. Well flowed 327 bbl of 42 deg oil per day through 32/64-in. choke from perforations at 5904-12 ft. It was bottomed at 5932 ft. Gas-oil ratio was 600 to 1.

★ Shell Oil Company has a new discovery in the Palo Duro Basin area of Oldham County. The company's No. 1-B Alamosa Ranch, in League 315, State Capitol Lands, 12 miles northeast of the town of Vega, flowed at the rate of 612 bbl of oil per day from 7122-32 ft. The new pool is 5½ miles southeast of Shell's first strike in the area, which is making 408 bbl per day from the Missourian lime. A third potential strike is being tested in the area at No. 1 L-S Ranch, in League 304.

Exploration

ARKANSAS

★ Gulf Oil Corporation's unexpected and expensive gas discovery in Johnson County, in the northwestern part of the state, has accelerated activity in leasing and several operators are studying new drilling programs. The firm's No. 1 Tackett, which in flowing an estimated 3,100,000 cu ft of gas per day from the Atoka at 3350 ft, caught fire on being shutin and destroyed the drilling rig and injured crewmen. The well was being drilled by Fleet Drilling Company of Ada, Oklahoma, with a depth objective of about 6500 ft in the Hale formation. The shallow gas pay, totally unexpected and new for the area has sparked hopes for a big new Atoka gas play.

SARDINIA

★ Wintershall AG., Kassel, together with the government of the semi-autonomous Italian island of Sardinia, have founded a company which is to search for oil and natural gas deposits in the western part of Sardinia. Exploration rights for an area of 3500 sq miles covering the western half of the island were granted to the Societa per Azioni Idrocarburi Sardegna (SAIS), in which Wintershall has a majority interest. As surface-geological conditions in western Sardinia are not yet sufficiently known, SAIS will start with geological mapping, which will be followed by geophysical investigations probably late in 1958 or early in 1959. Wiag has decided to take part in the exploration for oil on Sardinia, as this island of the Mediterranean is not subject to the regulations of the new Italian Petroleum Act, which is disadvantageous to foreign companies.

WYOMING

★ Mountain Fuel Supply Company, et al, has a new gas-condensate pool find in Sublette County. The wildcat find is the No. 1 Dry Piney in the Green River Basin. Tests indicated 85 bbl per day of condensate and 7,400,000 cu ft of gas daily from the Frontier zone at 6948-76 ft. Well was bottomed at 7575 ft.

PANAMA

★ Champlin Oil & Refining Company has exercised an option to acquire a concession from the Republic involving about 870,000 acres. Champlin, who holds a 50 percent interest in the concession, shares with Kerr-McGee Oil Company and Southland Royalty Company, who each hold 25 percent interest. Seismic and surface work has been completed and two wells have been scheduled for drilling early next year.

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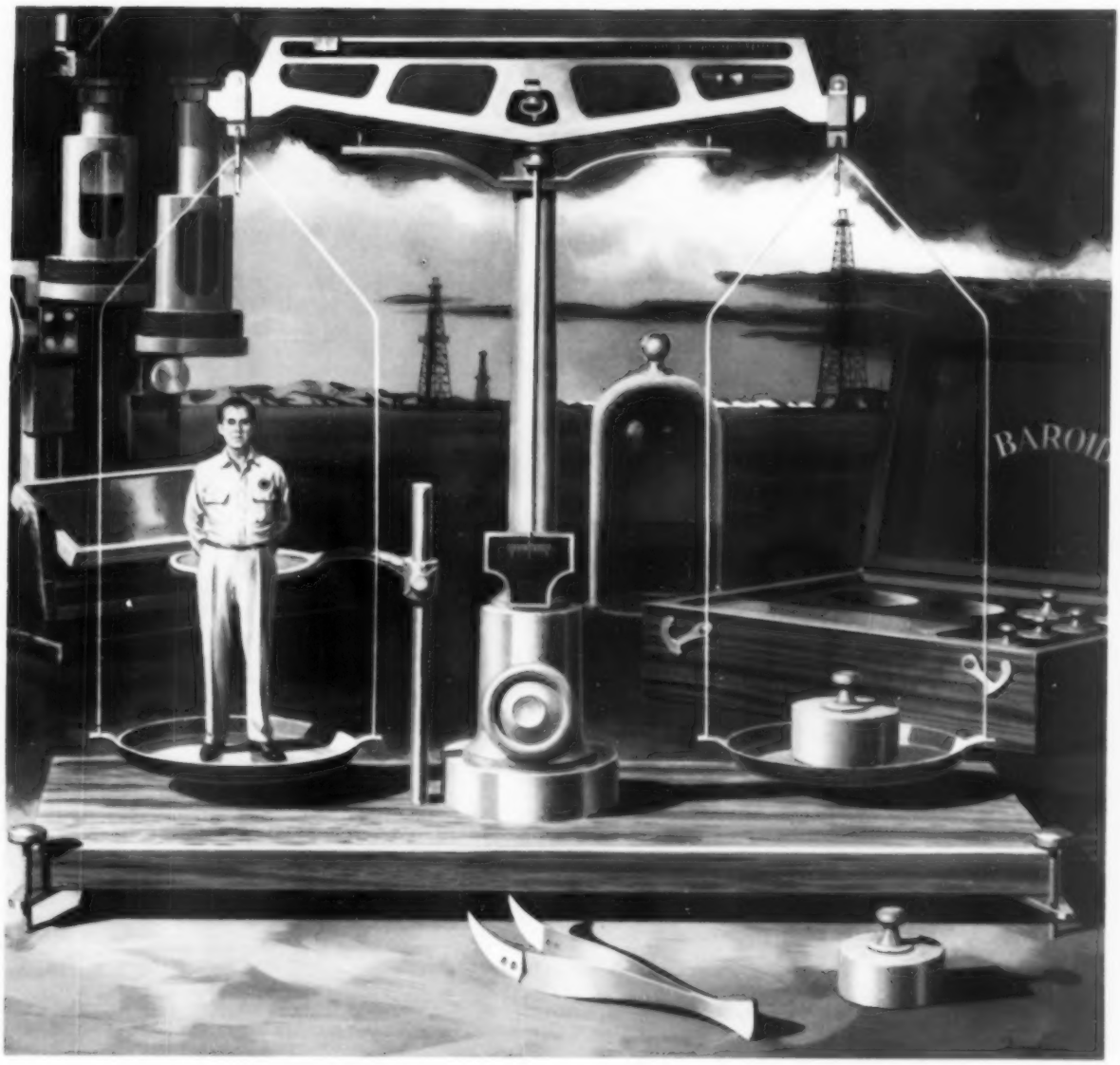

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Your drilling success can depend on the ability of the field engineer who plans your mud program and makes on-the-well mud checks and recommendations. Baroid's outstanding reputation has been built by the skill of its field men. They are sifted from hundreds of applicants, trained in Baroid's own school, and then field-tested under the sharp eyes of old timers.

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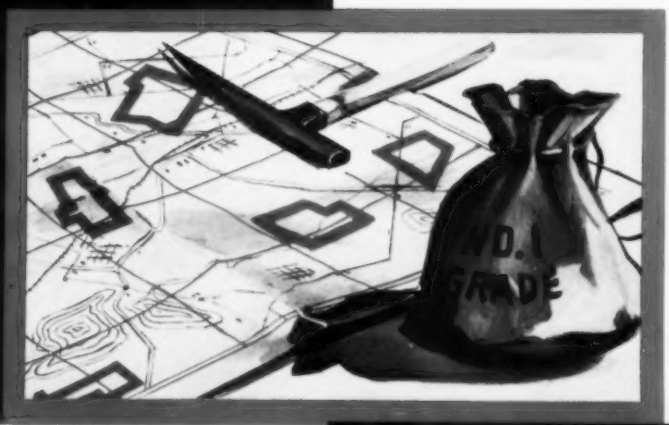
For the Best in Mud Weight

NOTHING BEATS BAROID



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Seismic Crew Fits Out For Turkey

A village was assembled and shipped from Houston to outfit for a seismograph crew leaving the Port of Houston.

The huge array of vehicles and boxes is the property of Geophysical Associates International, Inc. The Houston firm will search for petroleum possibilities in remote areas of Turkey for Mobil Exploration Mediterannean.

The 14 trucks, jeeps, trailers, crates and boxes left the Port early this week. Unloading will be in the Turkish port of Iskenderun.

Everything needed for seismic operations and everything to house and feed 40 or 50 people is included in the shipment.

The larger items are: 2 air-water drilling trucks, 3 waters trucks, 1 recording truck, 1 shooting truck, 1 party chief truck, 1 surveyor's truck, 1 reel truck, 3 cargo carriers, a supervisors jeep station wagon, water conditioning trailer unit, garage trailer (miniature workshop), portable garage building, 2 steel storage buildings, Kitchen

trailer, 2 air-conditioned bunk trailers, 1 air-conditioned trailer office, utility trailer (for baths, laundry facilities, etc.), trailer with 2 electricity generating plants, portable mess hall, and canvas equipment to feed and house 30 Turkish workers.

Ten Americans will fly to Turkey later to supervise the seismic operations. Four of these will take their families, the families to live in Beirut.

IN PROCESS INSTRUMENTATION

BARTON BELLOWS TYPE RECORDERS are the answer to industry's metering needs where dependability and precise measurement are essential. Modern in design, BARTON RECORDERS offer the advantages of rugged construction, simple operation, easy installation and low maintenance, combined with fast response and high sustained accuracy. BARTON RECORDERS are available with differential pressure ranges from 0-20"W.C. to 0-50 PSI with safe working pressures to 6,000 PSIG. Static pressure elements are available in ranges from 0-30" M.V. to 0-10,000 PSIG. All units are hydraulically tested and overranged to 1.5 times the safe working pressure, regardless of the differential range.

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What's doing in DRILLING

★ **Strain Drilling Company** of Denver, Colorado, has purchased an additional rig for its contract drilling activity in the Denver-Julesburg Basin area. The new rig is capable of 8000 ft drilling and is the second for the company in that region.

★ **Tri-State Chapter** of the AAODC has elected Henry Gwaltney, Evansville, Indiana, as its new chairman. Stuart H. Noah is the incoming vice chairman. Gwaltney heads the drilling company bearing his name, and Noah is manager of the Noah Petroleum Company of Albion, Illinois. The chapter is supporting Don Slape for AAODC national vice president at the national convention in Tulsa this month.

★ **Helmerich and Payne, Inc.,** Tulsa, Oklahoma, has announced the purchase of a deep drilling rig in Oklahoma from Superior Oil Company. It is to be added to the firm's fast-growing rig fleet in Venezuela. Cecil Campbell, one of H&P's top toolpushers, will accompany the rig to South America. Purchase price has not been disclosed. Rig has already been moved from Chickasha to Houston, Texas, for shipment.

★ **O'Neal Drilling Company,** formerly of Fort Worth, Texas, has moved its headquarters to Midland. John T. O'Neal Jr., vice president and general manager, and L. D. Thomason, office manager, are making the move to Midland. J. T. O'Neal Sr., founder and president, will continue to reside in Fort Worth. The firm operates five rotaries in the Permian Basin. Tom Williams, drilling superintendent has maintained offices in Midland since 1925.

★ **An elderly cable tool driller** in Terrell County, Texas, is eligible for several peculiar drilling records. Robert E. Freeman, 75, has been drilling intermittently at the No. 1 Barksdale, six miles north of Dryden, since August 2, 1945. This sets a record of 12 years on one hole. It is also believed that this is the deepest cable tool wildcat ever drilled west of the Mississippi. Although the well is now temporarily abandoned at a depth of 8710 ft, there are prospects that the well will again be re-entered because of a new pay find that may justify carrying the well to 9000 ft. The well was also drilled with a rig rated for 3500 ft drilling — another record, of a sort, for Freeman.

★ **Drilling cost increases have** prompted several meetings of Kansas rotary contractors. Recent hikes in bit costs, steel cost, and trucking rates have added from 10 to 15 cents per ft to the cost of Kansas drilling. The meetings have been at Wichita and Great Bend and have been for the purpose of analyzing these increases. Some contractors have been absorbing all the increased costs, a spokesman states.

★ **Anthony F. Keating,** president of the Keating Drilling Company, Tulsa, will be chairman of the important housing bureau for the 1959 International Petroleum Exposition. The bureau will be in charge of all reservations for housing made for the May 14-23 show and will co-operate with the Tulsa Hotel Men's Association. Keating will appoint his committee shortly.

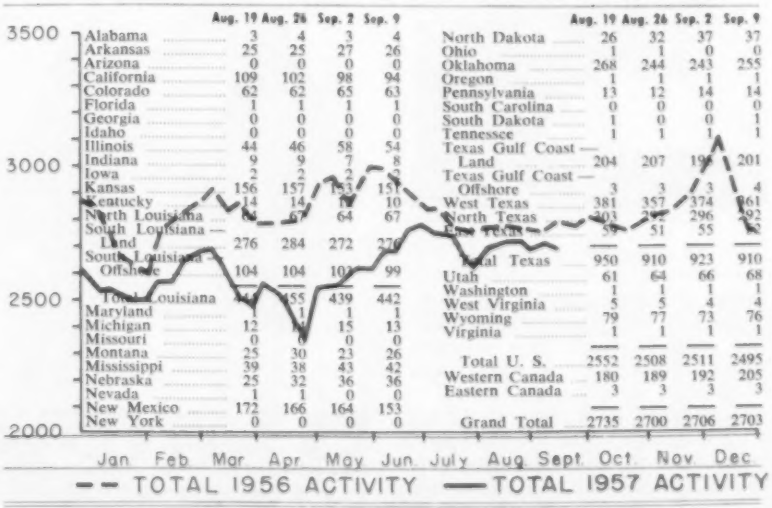
★ **Details of the offshore drilling structure** to be constructed next year on the state's submerged lands near Summerland have been disclosed by Standard Oil Company of California, Western Operations, Inc., operator and co-holder of the lease. A project which will approximate $2,000,000 in cost, the platform is designed to drill two wells simultaneously and will be capable of drilling a total of 25 wells, Standard said. The structure will have a deck 110-ft square, standing approximately 50 ft above the surface of the ocean on four supporting pillars. A 140-ft derrick will top the platform during the period of drilling operations. Afterward, the derrick and auxiliary equipment will be removed, leaving only the platform on the site. Location of the structure will be about 2.2 miles offshore and south of the town of Summerland, approximately opposite Loon Point, the company said.

★ **A new tool for financial management** of the drilling business is now available. This newest aid to the petroleum world is the AAODC Accounting Manual for the Oilwell Drilling Industry. The book has been in preparation for more than a year, and is reported to be a post-graduate course in accounting as applied to drilling. One of the most important additions to the new manual is a section devoted to the unit cost method of accounting. Under this method well charges are accumulated to arrive at a cost factor for each phase of rig operation. The unit cost factor is then applied on a uniform basis to each well account. This system is said to yield a more realistic appraisal of actual operating costs.

Rotary Rigs Operating in Oil Fields of United States and Canada

As reported to the American Association of Oilwell Drilling Contractors by Hughes Tool Company

	Aug. 19	Aug. 26	Sep. 2	Sep. 9
Alabama	3	4	3	4
Arkansas	25	25	27	26
Arizona	0	0	0	0
California	109	102	98	94
Colorado	62	62	65	63
Florida	1	1	1	1
Georgia	0	0	0	0
Idaho	0	0	0	0
Illinois	44	46	58	54
Indiana	9	9	7	8
Iowa	2	2	2	2
Kansas	156	157	153	151
Kentucky	14	14	10	10
North Louisiana	66	67	64	67
South Louisiana — Land	276	284	272	270
South Louisiana — Offshore	104	104	103	99
Total Louisiana	446	455	439	442
Maryland	1	1	1	1
Michigan	12	14	15	13
Missouri	0	0	0	0
Montana	25	30	23	26
Mississippi	39	38	43	42
Nebraska	25	32	36	36
Nevada	1	1	0	0
New Mexico	172	166	164	153
New York	0	0	0	0
North Dakota	26	32	37	37
Ohio	1	1	0	0
Oklahoma	268	244	243	255
Oregon	1	1	1	1
Pennsylvania	13	12	14	14
South Carolina	0	0	0	0
South Dakota	1	0	0	1
Tennessee	1	1	1	1
Texas Gulf Coast — Land	204	207	198	201
Texas Gulf Coast — Offshore	3	3	3	4
West Texas	381	357	374	361
North Texas	303	292	296	292
East Texas	59	51	55	58
Total Texas	950	910	923	910
Utah	61	64	66	68
Washington	1	1	1	1
West Virginia	5	5	4	4
Wyoming	79	77	73	76
Virginia	1	1	1	1
Total U. S.	2552	2508	2511	2495
Western Canada	180	189	192	205
Eastern Canada	3	3	3	3
Grand Total	2735	2700	2706	2703



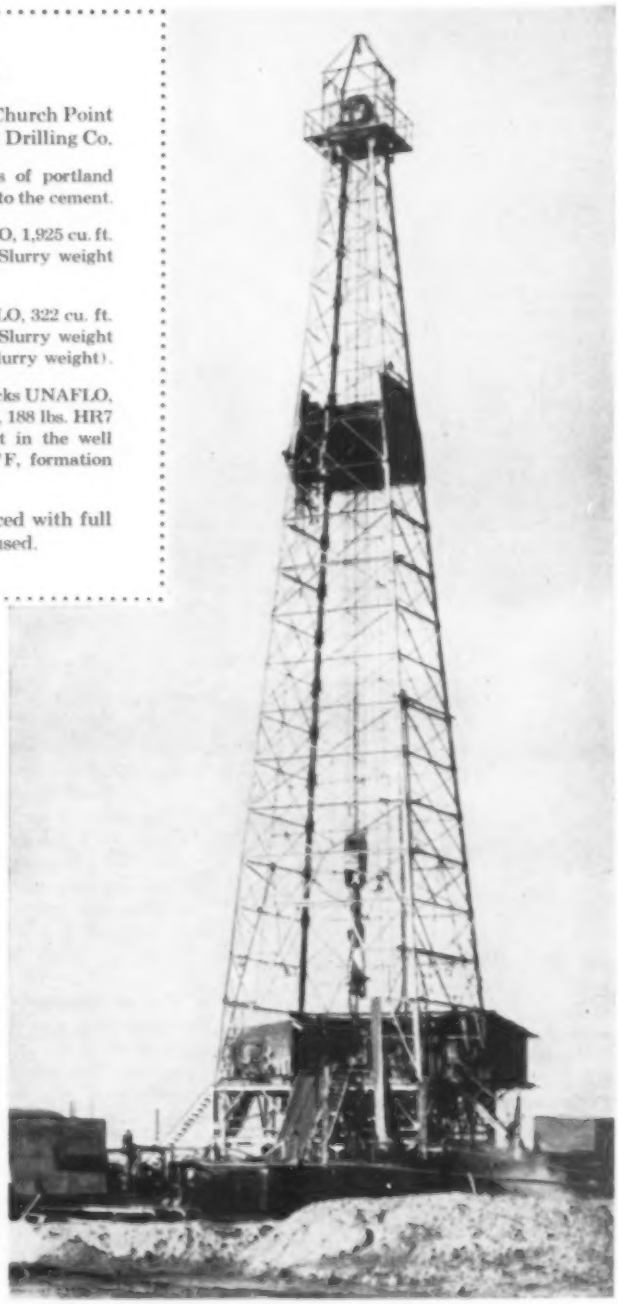
UNAFLO* with selected additives controls slurry weights in both shallow and deep wells

CEMENTING DATA

JOB: Tidewater Oil's Lease Homer Thibodeaux #1, Church Point Field, Acadia Parish, La. Drilled by: Falcon Seaboard Drilling Co.

1. 20" conductor pipe cemented at 540' with 372 sacks of portland cement, 372 cu. ft. Strata-Crete No. 6, and 4% gel added to the cement.
2. 13⅜" casing cemented at 4,990' with 1,925 sacks UNAFLO, 1,925 cu. ft. Strata-Crete No. 6, and 4% gel added to the cement. Slurry weight 13.4 lbs. per gal. Mud weight 10 lbs. per gal.
3. 9⅝" casing cemented at 12,917' with 1,610 sacks UNAFLO, 322 cu. ft. Strata-Crete No. 6, and 2% gel added to the cement. Slurry weight 15 lbs. per gal. Mud weight 15 lbs. per gal. (same as slurry weight).
4. 7" 38# RB4-P110 casing cemented at 14,488' with 665 sacks UNAFLO, 332 sacks Halliburton Hidense (Barite weight material), 188 lbs. HR7 retarder. Slurry weight 17.9 lbs. per gal. Mud weight in the well 18.1 lbs. per gal. Bottom-hole static temperature 280°F, formation pressure 12,395 psi.

Lightweight slurry cements used in Jobs 1 and 2 placed with full returns, giving calculated fillup for volume of slurry used.



- On deep jobs like this oilmen have learned that UNAFLO retarded oil-well cement can be pumped into place without a hitch.
- Slurries pump easily, stay fluid and pumpable under severe conditions of temperature and pressure.
- UNAFLO's *retarded set* gives vital extra time in emergencies, yet slurries form a strong, watertight, sulphate-resistant seal.

For typical data tables, write: Universal Atlas, 100 Park Avenue, New York 17, N. Y.

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* **"UNAFLO"** *is the registered trademark of the retarded oil-well cement manufactured by Universal Atlas Cement Company.*

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Drilling

★ **Shell's Rig 10** has been laid to rest for dismantling in shipyards at Harvey, Louisiana. Rig 10, an LST hulled marine barge, has ended an eight-year career drilling company wells in the shallow waters along the Louisiana Coast. The old rig outlived its usefulness as the search for oil extended into deeper Gulf waters; she was limited to waters about 15 ft deep. Equipment from the rig is to be moved to a new platform soon to be built at East Cameron, Block 82. Rig 10 spudded its first well on October 16, 1949, at Main Pass, and shortly thereafter drilled the discovery well in the Block 24 field. During its life, it has drilled 72 wells for a total depth of 706,549 ft. Last-year Rig 10 drilled 19 wells for a total depth of 174,301 ft.

★ **Drilling in Lake Erie,** on lands belonging to the state of Pennsylvania, may be expected to get underway soon. Two underwater lease blocks totaling almost 36,000 acres were sold on auction September 24. The 1957 general assembly approved an act permitting offshore development. State officials have indicated that drilling will not be permitted within one-half mile from shore, and extreme caution must be used within three miles because of fish breeding areas. Leases have already been sold in the lake on lands belonging to Canada.

★ **AAODC will join with Tulane** University School of Law as co-sponsors of the second symposium on "Legal Problems in the Tidelands." The program will be held Friday and Saturday, October 18-19 in Dixon Hall Auditorium on the Tulane campus in New Orleans. Lecture topics to be covered include Coast Guard regulations, insurance, drilling contracts, taxation, labor problems, personal injury, charter of vessels, and ship construction and financing.

Registration is open to all persons interested in tidelands law, with attendance expected from law firms, drilling contractors, supply companies and oil operators. A nominal fee of $5 is charged. Advance registrations are being accepted by the Program of Professional Study, Tulane University, School of Law, New Orleans 18, Louisiana.

★ **Douglas Oil Company of California** currently is embarked on an aggressive development drilling program in Santa Maria, East Anaheim and West Wilmington, California. Through its recent acquisition of Apex Petroleum Corporation, Ltd., Douglas Oil now has a joint interest in 66 wells completed in the West Wilmington field since development originally was started in April 1956. Douglas Oil's operating interest varies here, but in general, is a one-third partnership with Morton & Dolley and F. E. Fairfield, each owning one-third. In addition to the 66 wells, which are producing 2200 bbl per day, one well currently is drilling and two more locations have been staked. Site clearances and permits are progressing on a number of additional locations and approximately 25 new drill sites are left for the partnership to drill.

Canadian drilling is for the bears, as anyone can plainly see in the photo above. The bear isn't the wild variety sometimes encountered by drilling crews in the North Country . . . otherwise the "regular" driller wouldn't be at ease. The bear came too close to the rig and you can see what happened. Photo by Dave Willis, Magcobar.

★ **Falcon Seaboard Drilling Company** has negotiated for the purchase of a shallow water barge rig which will go into operation early next year. The barge rig is designed for semi-protected water operations along the Texas and Louisiana coast, announces T. N. Law, company president. Venezuelan subsidiary D&D Drilling and Construction Company, has negotiated for the purchase of two heavy duty steam rigs. It is anticipated that the rigs will begin operations in eastern Venezuela by the end of the year. Bolivian Gulf Oil Company, in which D&D owns an interest, now has a heavy duty power rig in that country and is expected to begin drilling the first well within 45 days.

★ **Drilling in 600 ft water** is now possible, says R. L. LeTourneau, in a paper delivered before petroleum engineers in Tulsa September 24. Occasion was the annual meeting of the American Society of Mechanical Engineers, Petroleum Mechanical Engineering Conference.

LeTourneau's paper reportedly outlined: Basic and technical requirements for platforms capable of drilling in waters 100 to 600 ft deep; how multiple wells can be accomplished from a single mobile platform; conversion of mobile platforms to fixed platforms for development operations; probable costs for units designed for super-depth waters, factors of equipment obsolescence, and other platform elements pertinent to opening new offshore areas.

★ **Texam Oil Corporation,** San Antonio, Texas, has sold its 50 percent interest in Adkins Drilling Company for $40,000 cash to John J. Adkins, founder and managing partner of the drilling company. When it acquired interest in Adkins Drilling in 1942, Texam Oil installed a rig with drilling capacity of 10,000 ft. Texam has earned around $63,000 from the Adkins operations over the past 10 years.

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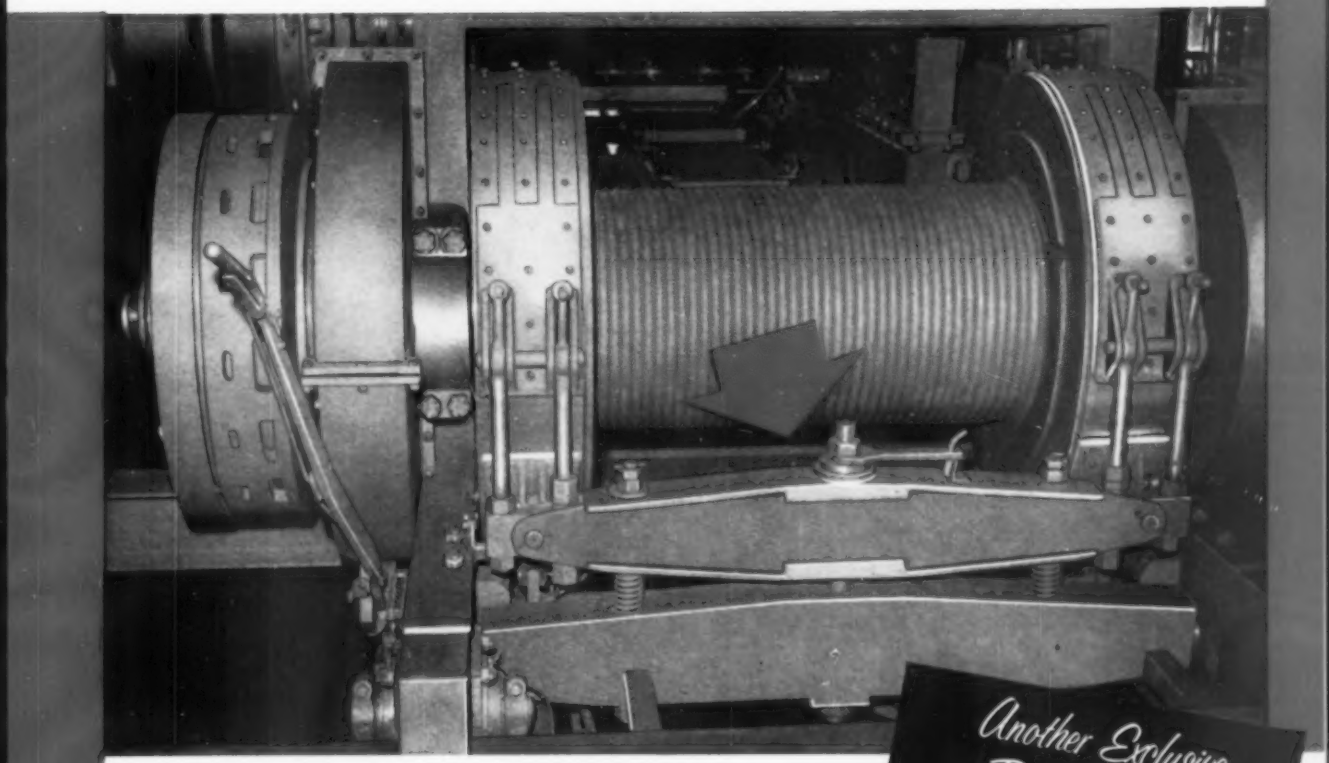
ONLY on WILSON SUPER RIGS!



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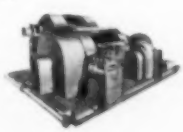

Super Titan "56"
15,000 Ft.—4½" Drill Pipe
19,000 Ft.—3½" Drill Pipe

Super Atlas
11,000 Ft.—4½" Drill Pipe
13,000 Ft.—3½" Drill Pipe

Super Giant
9,000 Ft.—4½" Drill Pipe
11,000 Ft.—3½" Drill Pipe

Super Mogul
7,500 Ft.—4½" Drill Pipe
8,500 Ft.—3½" Drill Pipe

A WHOLE NEW LINE OF RIGS

RUNNING TOUR with MEN in the INDUSTRY

Rex Shaver has been appointed assistant to the president of Rimrock Tidelands, Inc. He was with Big Chief Drilling Company as a contract representative. When an affiliated company, Big Chief Western Drilling Company, changed its name to H. L. Rowley, Inc., Shaver was elected vice president, directing the company's production and drilling operations. He advanced to executive vice president in 1955 and to president in February 1956.

Rex Shaver

W. L. Taylor

Warren L. Taylor has been named to the newly created position of chief geologist for El Paso Natural Gas Company. Taylor served until recently as division superintendent for the company at Salt Lake City, Utah. Also announced were other changes in the department, including formation of a new division office at Amarillo, Texas, and appointment of new superintendents at three of the company's five geological divisions. **A. E. Miller Jr.**, a geologist for the firm at Salt Lake City, was transferred to Amarillo as division superintendent. **J. G. Wilkins** was named superintendent of the Salt Lake division, replacing Taylor; **Roy L. Prichard** was named superintendent at Farmington, New Mexico, replacing **William L. Speer,** and **Larry C. Zink** was named superintendent of the Midland, Texas, division, replacing **Roy Allen.**

Retirement of **James E. Buckley** and the naming of **Wesley F. Weed** to succeed him as manager of the land department for Sun Oil Company's southwest production division has been announced. **A. J. Viets,** regional landman, succeeds Weed as assistant manager of the land department, and will continue to serve as a regional landman. **S. N. Jackson,** formerly crude oil solicitor, moves up to regional landman.

Robert L. Elston, division exploration superintendent with the Tulsa division of Sinclair Oil & Gas Company, has been named assistant manager of the Midland division. Elston succeeds **Loren L. Ware,** who has been named to general superintendent of exploration for Sinclair and transferred to company headquarters in Tulsa.

Creation by Tennessee Gas Transmission Company of a new district office at Durango, Colorado, for the administration of oil and gas exploration activities in that area has been announced. Manager of the new Durango exploration district is **John Simons,** formerly district geologist in the company's Salt Lake City office. Others assigned to the Durango office are **J. D. Moon,** as district landman, and **C. S. Algire,** as geologist. **A. N. McDowell,** formerly Gulf Coast exploration division manager in Houston, is being transferred to Calgary, Alberta, as manager of the Canadian exploration division. He will be succeeded as head of the Gulf Coast division by **J. P. Roach,** formerly staff geologist at the company's headquarters in Houston. In other Houston changes, **J. Spencer Collins** has been promoted from staff geologist to staff manager; **L. B. Vaden** and **George Burgher,** formerly staff landmen, have been named land activities supervisors, and **J. M. Browning,** formerly district exploration manager in Calgary, has been named staff geologist. Other appointments announced were: **Robert N. Grace,** as district geologist at Salt Lake City; **Jack Morris,** as district exploration manager at Denver; **Ray Marvin,** as district geologist at Denver; **Tom Perryman,** as district landman at Midland, Texas; and, **Delwyn Hunt, Ben Urbish** and **Don Wright,** as exploration clerks in company division offices at Midland, Denver and Oklahoma City, respectively.

J. L. Sleeper Jr. has been appointed staff geologist of The Texas Company's producing department — domestic with headquarters in New York. He has been assistant division geologist, West Texas division, at Fort Worth, Texas, since September 1956.

Promotion of **Joseph W. Lea** to regional geologist and the shifting of another regional geologist, **Dr. Edward W. Hard,** of Sun Oil Company's southwest production division have been announced. Lea was a senior geologist in the division headquarters at Dallas for the past two years. Hard was regional geologist for this eastern region since 1949.

D. S. Godshalk, Ponca City, Oklahoma, has been promoted to assistant manager of Continental Oil Company's geophysical section, with headquarters in Houston. He formerly was superintendent of operations for Conoco's geophysical section.

D. Carlton Jones has been appointed assistant manager of production for Hudson's Bay Oil and Gas Company, Ltd. He joined H.B.O.G. in October 1954 when he was named superintendent of natural gas utilization, a position he held until his new appointment.

Warren L. Davis, Houston, has been promoted to the newly created position of division geophysicist for Continental Oil Company's CATC marine region, with headquarters at New Orleans, Louisiana. He formerly was a member of the CATC geophysical staff at Houston.

John W. Gregg has been appointed general manager and vice president of New Superior Oils of Canada Ltd. Prior to his new appointment, in addition to his duties in teaching petroleum engineering courses at the University of Alberta, Gregg did consulting work for major and independent oil companies.

Joseph Walla Jr. has joined Northern Natural Gas Producing Company as district geologist at Calgary, Alberta, Canada. The company is a subsidiary of Northern Natural Gas Company. Prior to joining Northern Natural he was associated with Creole Petroleum Corporation for approximately 10 years in Venezuela, South America.

J. W. Moore, formerly senior exploitation engineer in head office production, Shell Oil Company in New York, has been named manager of the Houston division production department. He succeeds **G. D. Robertson,** who has retired. **R. J. Dobson,** area production superintendent, has been serving as acting division production manager until a permanent replacement was selected.

Division and branch managers of Phillips Petroleum Company's research and development department gathered at the Phillips Research Center, Bartlesville, Oklahoma, to observe the flag-raising ceremony marking the completion of 10 years and seven million man-hours of work without a disabling injury by the Bartlesville employees of the research division. Officiating at the ceremony were **R. W. Thomas,** vice president, research and development; **P. M. Arnold,** department manager; **J. A. Reid,** director of research; **Darrell Phillips,** manager of the employee relations department, representing the company's safety division; **Warren Felton,** assistant to the executive vice president; and **J. N. Romine,** safety director for the research and development department.

Keith L. Diehl has been elected vice president of Drilling and Exploration Company of Delaware, Inc., with headquarters in Dallas, Texas. Diehl was formerly manager of drilling and production for Edwin W. Pauley, San Antonio, Texas.

Charles A. Miller has been promoted from assistant superintendent to district superintendent of Magnolia Petroleum Company's Kermit producing district. He replaces the late E. G. Blundell.

B. J. Lancaster has been named resident engineer for Atlantic Refining Company's engineering and construction department in Dallas. He will have charge of E&C's Southwest and Venezuelan sections. In his new position, Lancaster succeeds the late Darcy W. Henwood. Before his appointment as resident engineer he was field group supervisor for E&C's Southwest section.

B. J. Lancaster

A. J. Wessely

H. J. Gruy and Associates, Petroleum Consultants of Dallas, Texas, announce the addition to their staff of **Arthur J. Wessely.** For the past two years he has been senior geologist in the engineering and consulting department of Core Laboratories, Inc.

Jack M. Saunders, Houston, has been promoted to division geologist for Continental Oil Company's Corpus Christi, Texas, division. Formerly assistant to Conoco's southern region geologist, he succeeds **Lloyd Ryman,** who has transferred to Caracas, Venezuela, as a member of the staff of Continental Oil Company of Venezuela, a Conoco subsidiary. It was announced at the same time that **R. W. Blair,** Houston, will succeed Saunders as assistant to the southern region geologist.

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PESA

Running Tour

▸ **Glen Lewis** has been named insurance and safety director of the Falcon Seaboard Drilling Company, Tulsa, and **T. N. Law Jr.,** has been named public relations director and assistant manager of the exploration department.

▸ **F. A. Bush** and **Carl G. Drescher** have been elected vice presidents of Sinclair Oil Corporation. The two new officers will be executive assistants to the executive vice president for operations, **E. L. Steininger.** Bush will be concerned with production and research operations and Drescher with foreign operations, exclusive of Venezuela, and with the purchase and sale of foreign crude oil.

Bush is a vice president and director of Sinclair Oil & Gas Company, producing subsidiary of Sinclair Oil Corporation, and is a director of Sinclair Research Laboratories, Inc. Drescher has been assistant director of foreign operations, exclusive of Venezuela.

▸ Amurex Oil Company has announced a number of administrative changes to carry out organization plans contemplated when Amurex acquired the properties of Ponder Oils Ltd.

W. L. Falconer, executive vice president, has been named president to succeed **C. H. Murphy Jr.,** and **Vernon Van Sant Jr.,** controller, has been elected executive vice president. **Edward Emrick Jr.** and **C. J. Hoke** will retire as vice presidents of the company, as will **J. A. O'Connor Jr., L. R. Beasley** and **H. Y. Rowe,** as secretary, treasurer, and assistant secretary, respectively. **J. H. Berry** will continue as vice president in charge of drilling operations.

▸ **S. T. Algermissen,** who received a PhD degree in geology and geophysics this spring from Washington University at St. Louis, Missouri, has joined Sinclair Research Laboratories, Inc., in Tulsa, doing geophysical research at the laboratories.

▸ **Earnest E. Campbell** has been promoted to assistant superintendent of Magnolia Petroleum Company's natural gas department with headquarters in Dallas. Campbell is presently district superintendent at Morgan City, Louisiana. He is in charge of the natural gas operations in the Gulf of Mexico.

▸ The Bell Oil and Gas Company announced the addition to its staff of **Dr. August Goldstein Jr.** as chief geologist. Prior to his joining Bell, Dr. Goldstein was associated with Pan American Petroleum Company.

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R. O. Garrett

▸ **Robert O. Garrett,** vice president and general manager of Texas Gas Exploration Corporation, Houston, has been elected to the company's board of directors. Election of **James W. O'Keefe** as treasurer of the exploration corporation, and appointment of **W. J. Wooten** as manager of its land department were announced at the same time.

J. W. O'Keefe

W. J. Wooten

O'Keefe had been comptroller of Texas Gas Exploration, and Wooten was recently employed by the company.

▸ **R. J. Graebner** has been appointed to the post of geophysicist for U.S. and Canadian operations of Geophysical Service Inc. He held the position of senior research seismologist prior to his new appointment.

▸ **Brad Keyes,** formerly with the New Mexico Oil Conservation Commission, has been elected president of Geolectric, Inc., Aztec, New Mexico.

▸ **R. H. Tipton** has been named acting superintendent of the West Texas-New Mexico division of Loffland Brothers Company. Tipton is replacing **J. D. Poe** who will take an extended vacation before resuming his activities with the company. Tipton has been assistant superintendent of the West Texas-New Mexico division.

▸ **Thomas M. Hendrickson** has been appointed geologist of the Gulf Coast division of Rimrock Tidelands, Inc., Shreveport. He served as division geologist for the Frankfurt Oil Company for two years.

▸ **Arnold G. Radke** has been promoted to general drilling superintendent and **Calvin Roberts** to drilling superintendent, Kansas-Oklahoma district, of Garvey Drilling Company.

▸ Leibrock, Landreth & Campbell, consulting petroleum engineers have announced the new location of their offices in Midland National Bank Building.

▸ **Fred B. Asche Jr.** has been named to the Dallas administrative staff of Tekoil Corporation. He was formerly associated with Chubb & Son, marine underwriters of New York and New Jersey and with Great National Life Insurance Company in Dallas.

▸ Two promotions to foreign affiliates of Mobil Oil of Canada, Ltd. have been announced. **A. E. Barroll,** formerly production superintendent, has been named to a new post as manager of exploitation for Mobil Overseas Oil Company in Paris, France. **D. G. Price,** formerly district production superintendent in Regina and Weyburn, becomes drilling superintendent for Mobil Exploration Portugal, Inc.

▸ **Jess L. Warren,** prominent east side (New Mexico) geologist, has been appointed as secretary-treasurer of Shelton-Warren Oil Company. His first association with Shelton came last year when he joined the Shelro Drilling Company at Lovington (New Mexico) as general manager. Earlier this year he and Shelton formed a partnership and from this evolved long-range plans that have been consolidated with the founding of the Shelton-Warren Oil Company.

▸ Promotions and transfers of key personnel in the land and geological division of Cities Service Oil Company have been announced. **Murray G. Wells** becomes assistant chief geologist of the company succeeding **E. W. Dissler,** who has been named resident manager of Canada-Cities Service Peteroleum Corporation, with headquarters in Calgary, Alberta, Canada. Wells, who has been manager of exploration, Mid-Continent division, for the company, with headquarters in Bartlesville, is succeeded by **Barron Housel,** who has been assistant superintendent of the land department. **Mark Payton,** division landman for the Mid-Continent division, becomes assistant superintendent of the land department. Succeeding Payton as Mid-Continent division landman is **Rex Tarr,** who has been assistant division landman at Midland, Texas.

▸ **Robert P. Evans** has been elected vice president and a director of Kin-Ark Oil Company. He joined Kin-Ark after 11 years with Lion Oil Company as manager of the firm's central region in Wichita, Kansas.

▸ Humble Oil & Refining Company announced 13 promotions and transfers in its production department.

M. H. Cunningham has been promoted from supervising civil engineer to assistant division civil engineer in the eastern division office. He replaces **Jack S. Toler** who was transferred to Houston as division civil engineer. **R. L. Lindauer,** senior petroleum engineer, petroleum engineering division, Houston, has been transferred to the East Texas division office as supervising petroleum engineer, reservoir analysis. **J. W. Glanville,** senior petroleum engineer in the reservoir analysis group of the petroleum engineering division has been promoted to supervising petroleum engineer, reservoir analysis, Gulf Coast division office. **L. E. LeFlore,** from senior petroleum engineer, eastern division office, to supervising petroleum engineer, reservoir analysis, eastern division office. **V. R. Sage,** petroleum engineer in the Stratton district, southwest Texas division, to senior petroleum engineer. **W. H. Alston,** senior district clerk, Stratton district, to assistant district chief clerk at the Kelsey district, southwest Texas division. Alston replaces **W. J. Allen** who was transferred to the Greta district. **W. G. Farmer,** assistant district chief clerk at Greta, to district chief clerk at King Ranch gas plant construction district. **R. L. Epps,** from district chief clerk, Castaic Junction, California area, to Goose Creek district, Gulf Coast division, as assistant district chief clerk. Epps was replaced at Castaic Junction by **N. H. Ratliff,** former assistant district chief clerk at Goose Creek. **V. L. Wimberly,** marine equipment pusher, petroleum engineering division, Houston, to civil engineering division, Houston as assistant division chief clerk. **J. H. Pittman,** senior civil engineer, Gulf Coast division, to the King Ranch gas plant construction district, civil engineering division.

With Magcobar on your well ...

you are on your way to a better cementing job

The biggest savings a good mud program brings you come from the difficulties and unnecessary expenses which are *avoided*. These savings don't show up in the mud bill. But in total cost, yes.

If you ran casing on schedule with no sticking, no bridging, you can be sure the mud and the hole were in proper condition. You saved again if your mud had the right gel characteristics for cementing, helping to prevent channeling. And, if after perforating, you found a good cement job with no communication between zones, you have avoided an expensive squeeze job. You saved, too, if hole was close to gauge, resulting in proper cement fill-up the first time.

When the mud is planned right and prepared right for each foot of hole, the cost of drilling each foot is reduced. And when the Magcobar team is working and planning with you, you get the industry's best qualified mud engineers, the best drilling muds and chemicals—at your well when you need them. To be sure Magcobar is on your next well, start planning with Magcobar now.

Magnet Cove Barium Corporation
Houston, Texas

Magcobar
Complete
DRILLING MUD SERVICE

57-103

New fracturing record set with torque converter drives

When a large southwestern oil company called in Dowell Incorporated, Tulsa, for fracturing a Borden County, Texas, oil well, 41 Dowell engineers arrived prepared for a major job.

With 29 pieces of equipment, two newly built polyethylene film-lined pits, 329,000 gallons of water and 225,000 pounds of sand, the men pumped a staggering 3000 gallons a minute into the well at 3500 psi. The result was that Dowell easily broke its own previously established world fracturing record.

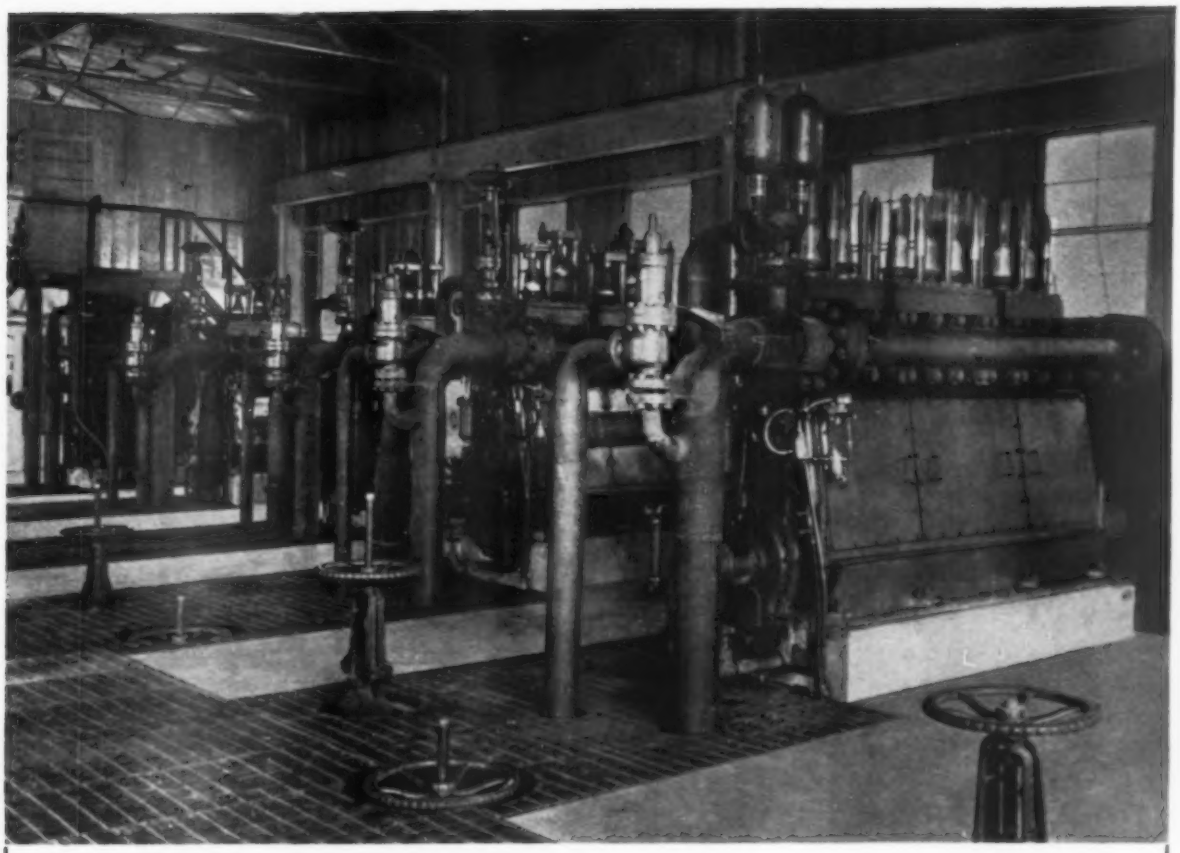
To handle this tremendous job, Dowell's equipment had to produce 15,000 gross hp and 6250 hydraulic hp . . . but Dowell had the equipment to produce it. For one thing, each fracturing unit was equipped with a 1500-hp engine. For another, each engine drove through a Twin Disc 16,000 Series Three-Stage Torque Converter. Thus regardless of the varying loads and pressures, the torque converters permitted the engines to operate in their most efficient rpm range and produce rated hp. They also provided more efficient operation because the power units were indirectly compounded by the load.

This, however, is only one of many oilfield applications where Twin Disc Torque Converters really prove their worth. Drawworks, rotary tables, mud pumps—whatever your power application problem, you'll find Twin Disc Torque Converters a simple but effective solution to cutting operating costs and producing greater profits. The smooth, shock-free flow of power through the fluid drive increases machinery life, reduces engine wear and minimizes downtime. Full engine hp can be maintained regardless of load . . . and torque multiplication up to 6:1 (three-stage) is available whenever the load demands it.

Take advantage of the many cost-saving features offered by Twin Disc Three-Stage or Single-Stage Torque Converters. See your local equipment dealer or Twin Disc representative or write to Twin Disc Clutch Company, Racine, Wisconsin; Hydraulic Division, Rockford, Illinois.

TWIN DISC
CLUTCHES AND HYDRAULIC DRIVES

TWIN DISC
Torque Converters



FIELD REPORT

FLOOD: Salem Unit

PUMPS: 10 Aldrich Pumps

2 Variable Stroke, 2 Triplex, 2 Quintuplex, 4 Septuplex

FLOODING STARTED: April 1953

EXPERIENCE TO DATE:

Pumps operating currently under 800 lb pressure, delivering 171,000 bbl a day. Handle mixture of fresh water and oil field brine. Routine maintenance every 4000 hours. Customer reports pump operation and Aldrich field service "satisfactory."

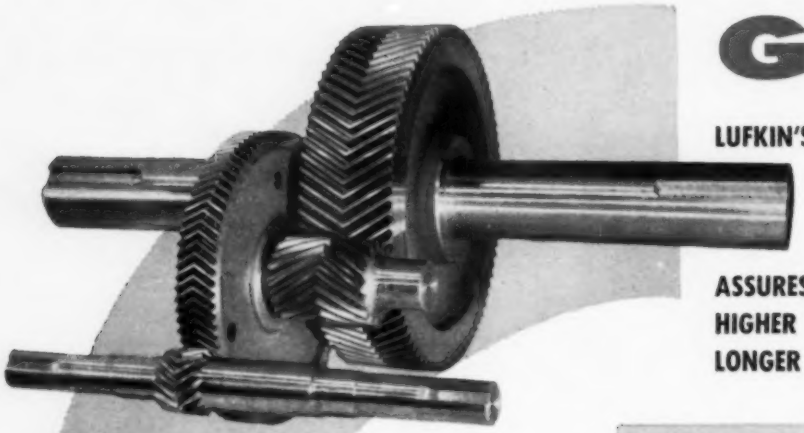
Field parts stock available in Carmi, Ill.; Charleston, W. Va.; Houston; Los Angeles; Odessa and Tulsa. For further information, write the Aldrich Pump Company, 3 Gordon Street, Allentown, Pa.

the toughest pumping problems go to ALDRICH

Insure

QUIET, EFFICIENT AND UNINTERRUPTED Power Transmission

with LUFKIN precision GEARS



LUFKIN'S PRECISION IN DESIGN AND PRODUCTION AS WELL AS THE SELECTION OF FINEST MATERIALS AVAILABLE ASSURES SMOOTH, QUIET OPERATION, HIGHER LOAD CAPACITY, AND LONGER LIFE

SPEED INCREASERS

SPEED REDUCERS

PUMPING UNITS

"precision" means . . .

- CORRECT PROPORTIONS
- ACCURATE TOOTH SPACING
- EXACT HELIX ANGLE
- PERFECT TOOTH CONTOUR
- FINE SURFACE FINISH
- PROPER ALIGNMENT.

MEMBER OF AGMA

Lufkin FOUNDRY & MACHINE COMPANY

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Houston • Natchez • Corpus Christi • Lafayette • Dallas • Kilgore • Odessa • Hobbs • Farmington, N. M.
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Oklahoma City • Seminole • Tulsa • New York • Maracaibo, Venezuela • Shreveport

Lufkin equipment in Canada is handled by
THE LUFKIN MACHINE CO., LTD., 9950 65th Avenue, Edmonton, Alberta, Canada, Regina, Saskatchewan, Canada

A. F. KNAPPENBERGER
DRILLING CONTRACTOR · OIL OPERATOR
GRAHAM, TEXAS

April 25, 1957

Mr. Gordon P. Street, President
The Wheland Company
Chattanooga, Tennessee

Dear Mr. Street:

We started using your pumps back in 1937 and have continued to do so to the present time. We now have one HP-8000 and one HP-14000 in operation, which we believe is the most economical pump on the market to operate today.

The above two pumps have been in operation for several years, with practically no cost to us at all.

We operate the two rigs in North Texas area and drill contracts, interest deals, and our own account from 2000 to 7500 feet.

Yours very truly,

K&H DRILLING COMPANY

By: A. F. Knappenberger
Partner

20-Year User

of

WHELAND SLUSH PUMPS

cites their

low-cost operation!

Currently in use by K&H are Wheland HP-8000 and HP-14000 Pumps:

". . . in operation for several years with practically no cost to us at all."

—A. F. Knappenberger, Partner

On location in North Texas, the Wheland HP-8000 pump which has performed so well for K&H Drilling Co.

At the side, left to right, are Mr. Alton Henley, Co-owner; Mr. A. B. Drake, Wheland representative; Mr. A. F. Knappenberger, Co-owner.

WHELAND

HP-8000 DUPLEX SLUSH PUMP
7-¼" x 12", 220 HP Nominal Input at 70 RPM

•

HP-14000 DUPLEX SLUSH PUMP
7-½" x 14", 350 HP Nominal Input at 60 RPM

•

Wheland builds a Complete Line of Efficient Slush Pumps.

Write for Detailed Bulletins.

WHELAND

ROTARY DRILLING MACHINERY

THE WHELAND COMPANY
CHATTANOOGA, TENNESSEE, U.S.A.
DRAW WORKS • SLUSH PUMPS • ROTARIES
CROWN BLOCKS • TRAVELING BLOCKS • SWIVELS

DOMESTIC DISTRIBUTORS: INDUSTRIAL SUPPLY COMPANY, INC.—Main Office: Wichita Falls, Texas • HOUSTON OIL FIELD MATERIAL COMPANY, INC.—Main Office: Houston, Texas • JONES AND LAUGHLIN STEEL CORPORATION, SUPPLY DIVISION—Main Office: Drawer 2481, Tulsa 2, Oklahoma.

EXPORT DISTRIBUTORS: LUCEY EXPORT CORPORATION—233 Broadway, New York 7, New York—Broad Street House, London, E. C. 2, England.

WHELAND

3 More New Rigs Get General Electric Drive for Land, Offshore Drilling

More and more rigs for both land and offshore applications are being specifically designed for electrified oil well drilling with General Electric drive systems. Here are just a few of the reasons why:

- Designed-in control simplicity of G-E drive eliminates complicated external apparatus, feed back systems, and torque limiting devices.
- General Electric drive gives you greatly increased flexibility. Fewer parts to service mean less maintenance time and expense.
- You can use General Electric drive with virtually any popular oil field engine. G-E drive is at least 85% efficient and helps eliminate mechanical drive losses.
- General Electric drive is available for a wide range of applications, including all normal drilling functions on land or offshore.

Like the operators of the three rigs described on your right, you, too, can obtain these benefits from a General Electric Drive System.

For more information, call your nearest General Electric Apparatus Sales Office or your International General Electric Sales Office. (Principal drilling offices in Dallas, Houston, New Orleans, Denver, Tulsa, and Los Angeles; Bogota, Maracaibo, Caracas, Buenos Aires, and New York.) General Electric Company, Locomotive and Car Equipment Department, Erie, Pa. 115-23

Progress Is Our Most Important Product

GENERAL ELECTRIC

1 **GREAT WESTERN RIG NO. 44,** equipped with a General Electric S-343 drilling rig package, is now drilling what may become the world's deepest hole for Phillips Petroleum Co. near Ft. Stockton, Texas.

2 **PENROD DRILLING COMPANY'S JIM WOODRUFF BARGE NO. 51,** designed to drill in 70 feet of open water. G-E B574 drive system includes five G-E generators and seven drilling motors.

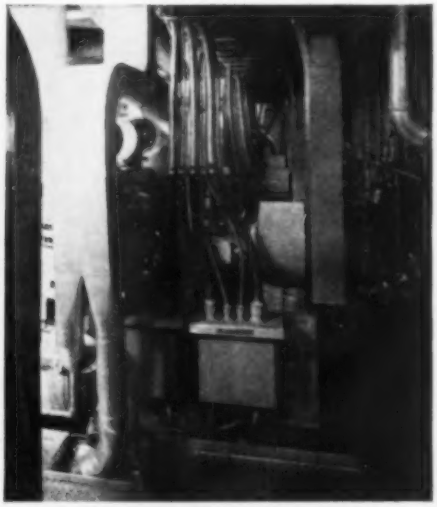
3 **CREOLE PETROLEUM BARGE NO. C228** is fitted with G-E drive components. Built to serve fixed or mobile platform, C228 has G-E B6743 drive system, White-Superior PTD-E8 diesels.

READY TO DRILL WITHIN 1½ DAYS, rapid rig-up was made possible by the portability of a G-E electric drive. Above, drawworks near derrick floor.

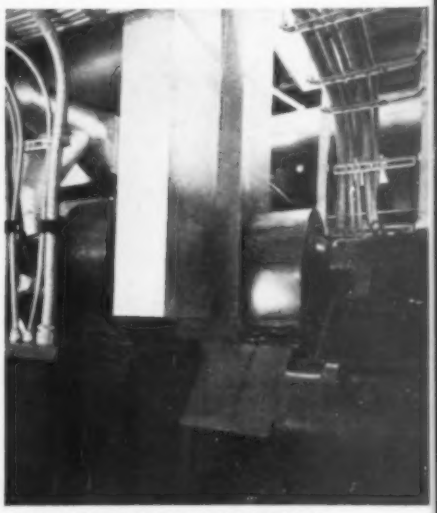
INCREASED FLEXIBILITY was gained with the use of G-E drive. Power skids with Cummins LRT-600 TURBODIESEL engines, G-E generators can be located "practically anywhere."

POWER CONNECTIONS ARE MADE QUICKLY with flexible cables, helping Great Western Drilling Company to speed operations.

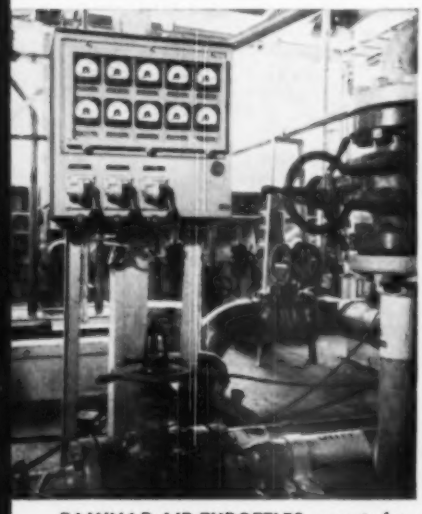
COMPACT G-E DRILLER'S CONSOLE gives operator better control of all electrically driven functions. Indicating ammeters, voltmeters are easy to read.



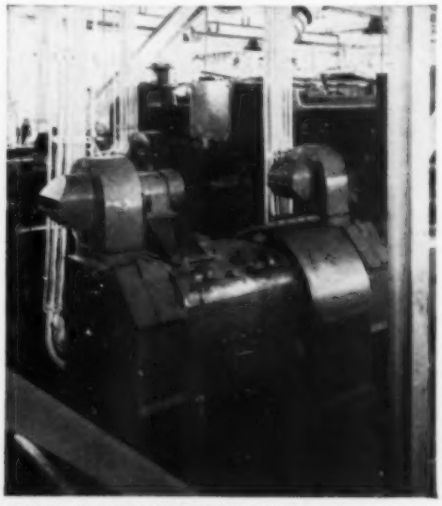
G-E 752J GENERATORS MATE PERFECTLY with Cat. D397 engines to produce reliable electrical power. Generators are reliable, easy to maintain, and have long life features.



EASIER EQUIPMENT SERVICING is made possible with G-E drive because power connections are flexible, can be easily broken.

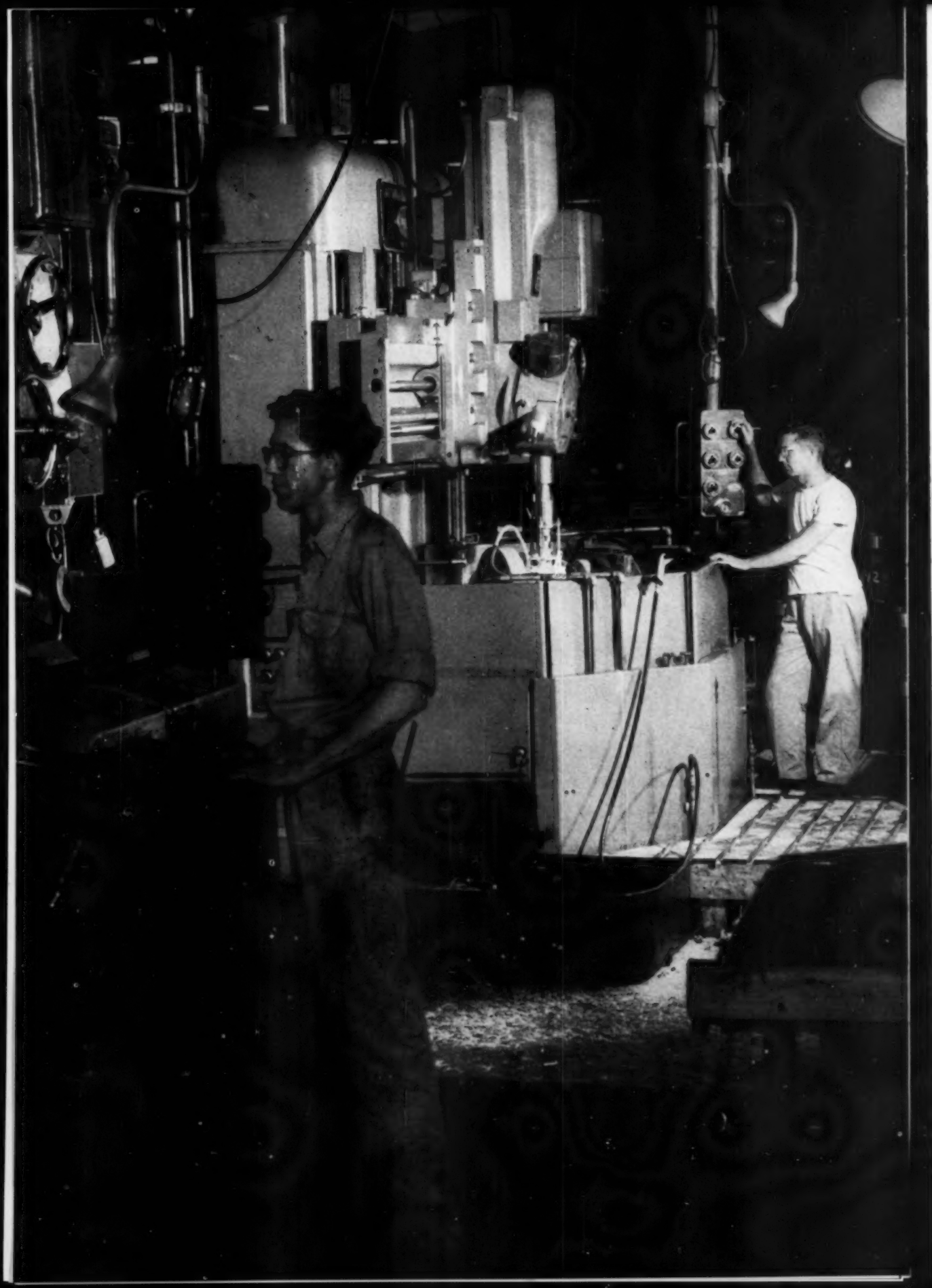


FAMILIAR AIR THROTTLES mounted on General Electric-built pump room operator's console permit fast, accurate pump control.



COMPLICATED CONTROL DEVICES ARE ELIMINATED aboard Creole's C228. Six G-E 752 drilling generators and seven G-E 752H motors have "built-in" control, protection features.

CONTROL DEVICES ARE EASY TO SERVICE. Main d-c control cabinet has only simple contactors, relays, resistors and air valves.



Faster Than the Hand

There's not a single machine in the shop at the Oil Center Tool Company that thinks for itself.

The best engineers available, the best craftsmen available are paid well to do that.

But, some of the machines come pretty close to being self-contained "brains."

"Hand made" products no longer denote perfection. Uniformity, quality and specialization are better achieved on the automatics.

And if the future does yield a real robot for the machine shop, O-C-T will have it.

The most modern, the most efficient in tools, automatic and otherwise,—that's another reason for the supremacy of O-C-T products.

Precision, specialized well control equipment isn't turned out by hand . . . it's turned out with machines faster than the hand.

Oil Center Tool Company got along pretty well back in 1927 with one milling machine, a drill press, shaper and two engine lathes in an 18 x 20-foot shop.

Today, the company's plant occupies more than 55,000 square feet of floor space with all facilities covering 13½ acres. That's only temporary, of course. Expansion is always under way.

O-C-T machines, like O-C-T products, are specialized and versatile.

The little ones turn out big jobs and the big ones sometimes turn out little jobs.

O-C-T machines take raw, dull-looking hunks of iron and steel and convert them into gleaming pieces of well control equipment that can handle the toughest, the most complicated assignments.

For example, two recent additions to the machine shop cost about $100,000 each.

Their purpose?—Mass production that still imbues the product with an individual personality.

The units can be preset to do specific chores, automatically boring huge castings; boring vertically or at angles; boring tapered holes, holes the same size—all with super speed.

The nerve center of these robot giants is a complicated case of delicate electronic equipment.

In the midst of an automatic boring job, these machines can be halted, switched over to manual control to turn out an emergency job, and then placed back on its original work with no time lost in resetting controls.

Ultra modern machine shops is one reason why O-C-T continues to set production records.

But production records mean nothing unless the products are precision-made.

And the O-C-T formula of advanced machines plus skilled workers results in the precision needed . . . in volume . . . by the oil industry.

At O-C-T they can not use aged machines to be first in the machine age.

O·C·T

A SUBSIDIARY of FOOD MACHINERY and CHEMICAL CORPORATION

OIL CENTER TOOL CO.

Export Representatives: South America — East West Oiltools, C. A., Del Lago Hotel, Maracaibo, Venezuela. Address Export Inquiries for All Other Countries to P. O. Box 3091, Houston, Texas.

THEY COST O-C-T nearly $100,000 each, but these two new automatics will get emergency jobs to oil operators days earlier.

Top Performance at Rock Bottom Cost

WITH THE

GUIBERSON

TYPE B TUBING SPIDER

Stock sizes 1" to 3"; spiders are available on special order for 2" x 1" and 2 ½" x 1 ¼" parallel strings.

The Guiberson Type "B" tubing spider is a fast-handling, lightweight tool that can be handled by one man if necessary—and the cost of the "B" is lightweight, too. No other spider in its class offers greater economy, either initially or in the long run.

Despite its exceptionally light weight, the Type "B" spider will hold the longest string, and release instantly without sticking when you pick up. All slips fit the same bowl, and the "B" will not distort or damage tubing. Self-equalizing slips with hard, sharp teeth, give full, large-area contact, assuring positive grip, better load distribution and perfect release.

For positive performance, maximum protection, amazing handling ease and surprisingly low cost, you can count on the sure-grip "B" Tubing Spider.

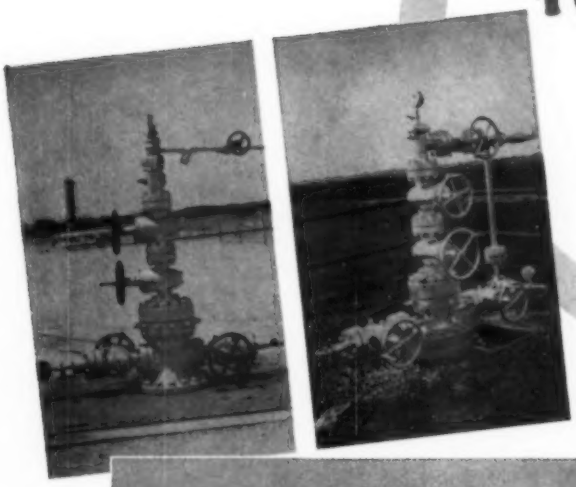
THE GUIBERSON CORPORATION

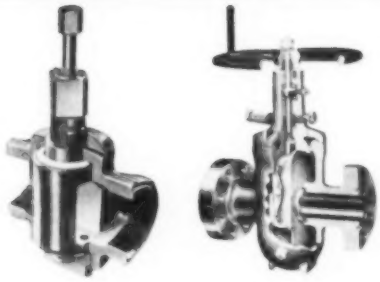
ESTABLISHED 1919
DALLAS, TEXAS
U. S. A.

Sold by
Oil Field Supply Stores
Everywhere

FROM W-K-M

high PRESSURE and low PRESSURE valves





Here's wide range availability for both high and low pressure services from **W-K-M**.

For safe and positive high pressure control on christmas trees, flow wings, and flow lines, it's **W-K-M** Through-Conduit Gate Valves to handle working pressures from 500 to 15,000 psi.

For "expressway" turbulence-free flow in oil and gas pipelines, it's **W-K-M** ASA Through-Conduit Gate Valves from ASA 300 lbs. to ASA 1500 lbs.

For gathering lines, manifolds, headers and similar low pressure services, it's **acf** Lubricated Plug Valves—200 to 500 lbs. WOG.

You need dependability, performance, minimum maintenance! You need **W-K-M** and **acf** Valves, designed specifically to meet your requirements, in oilfield services, on pipelines, in refineries, in process and chemical plants, and wherever valves are required to control the flow of liquids or gases.

Complete your file of valve information by writing for these W-K-M Catalogs. Address Dept. F-10.

W-K-M Catalog 200 W-K-M Through-Conduit Gate Valves For Oil Field Services
W-K-M Catalog 300 W-K-M ASA Through-Conduit Gate Valves
W-K-M Catalog 400 ACF Lubricated Plug Valves

W-K-M Catalog 800 ACF Lubricant Manual

W-K-M

DIVISION OF **acf** INDUSTRIES INCORPORATED

PLANT: MISSOURI CITY, TEXAS
MAILING ADDRESS: P. O. BOX 2117, HOUSTON, TEXAS

MANUFACTURERS OF W-K-M GATE VALVES · acf LUBRICATED PLUG VALVES · KEY-KAST ALLOY STEEL PIPING FITTINGS · KEY RETURN BENDS AND FITTINGS

5709

No. 4 in a series . . . Reed Rock Bit **Firsts** in Famous Fields

Reed Rock Bits

BEST IN 1932
BEST TODAY!

Reed introduced the *first* rock bit with roller bearing cutters unitized into a lightweight drilling head during the Oklahoma City Bonanza. Prior to this first bit with welded-in cutters and lightweight head known as the "Sport Model," all bits with rolling cutters were dressed at the rig and a 9-inch bit weighed about 350 pounds. But let's turn back the pages to the beginning of the Oklahoma City field and the era of wild gushers.

On December 28, 1928, the bit on the Indian Territory Illuminating Oil Company's No. 1 Oklahoma City well pierced a cement plug at 6,355 feet and the well blew in, producing 4,909 barrels of oil in the first twenty-four hours. This was it . . . the Oklahoma City Bonanza was on. The field expanded steadily to northward and for the first time a major metropolitan area was threatened by a vast oil field. Derricks, slush pits, and storage tanks invaded industrial and residential areas alike.

The field developed on spectacular proportions with newspapers carrying frequent headlines on sensational gushers. Most awe-inspiring of all these uncontrolled gushers was the "Wild Mary Sudik" which blew in with an estimated 200 million cubic feet of gas and 20,000 barrels of oil daily. "Wild Mary" rampaged for eleven days showering oil on farms for five or six miles about. Floyd Gibbons, famous war correspondent, broadcasted "Wild Mary's" antics twice daily to a radio-listening world. In efforts to control prorations in the prolific Oklahoma City field, national guardsmen were used on several occasions and it was variously described as "Turning the Oil Tide with Rifles" and "The Era of Gushers and Guardsmen."

Oklahoma City was significant as the first extensive area of "deeper" wells, made possible by the vast improvement in rigs and rotary equipment. Prominent on this list of improvements was the Reed "Sport Model" rock bit. Today, the greatest improvement in rock bit design for modern fast drilling requirements is the Reed Y Bit.

BEST IN 1932 . . .

Reed Sport Model Rock Bit with roller bearing cutters unitized into lightweight drilling head — 1932.

BEST TODAY . . .

REED Y BIT

FREE REPRINT

This is the fourth of a series on the history of famous fields. To obtain your FREE 17 x 14" full color prints suitable for framing of the entire series, send your request to Department H, Reed Roller Bit Company.

OKLAHOMA CITY · 1932 As the field developed northward, rigs reared their crown blocks in school yards, slush pits were dug on playgrounds, and storage tanks were built in alleys. Hundreds of derricks were visible from the capitol steps. Rigs actually invaded the capitol grounds in 1936.

REED ROLLER BIT COMPANY

HOUSTON 1, TEXAS

DIAMOND . . . most widely used roller chain in the oil field

Oilmen say "Diamond cuts drilling costs" . . . back their words by buying more Diamond than ever before!

Drillers' records *prove* that Diamond Roller Chain costs less to use. It lasts longer. It is more dependable. It eliminates costly downtime.

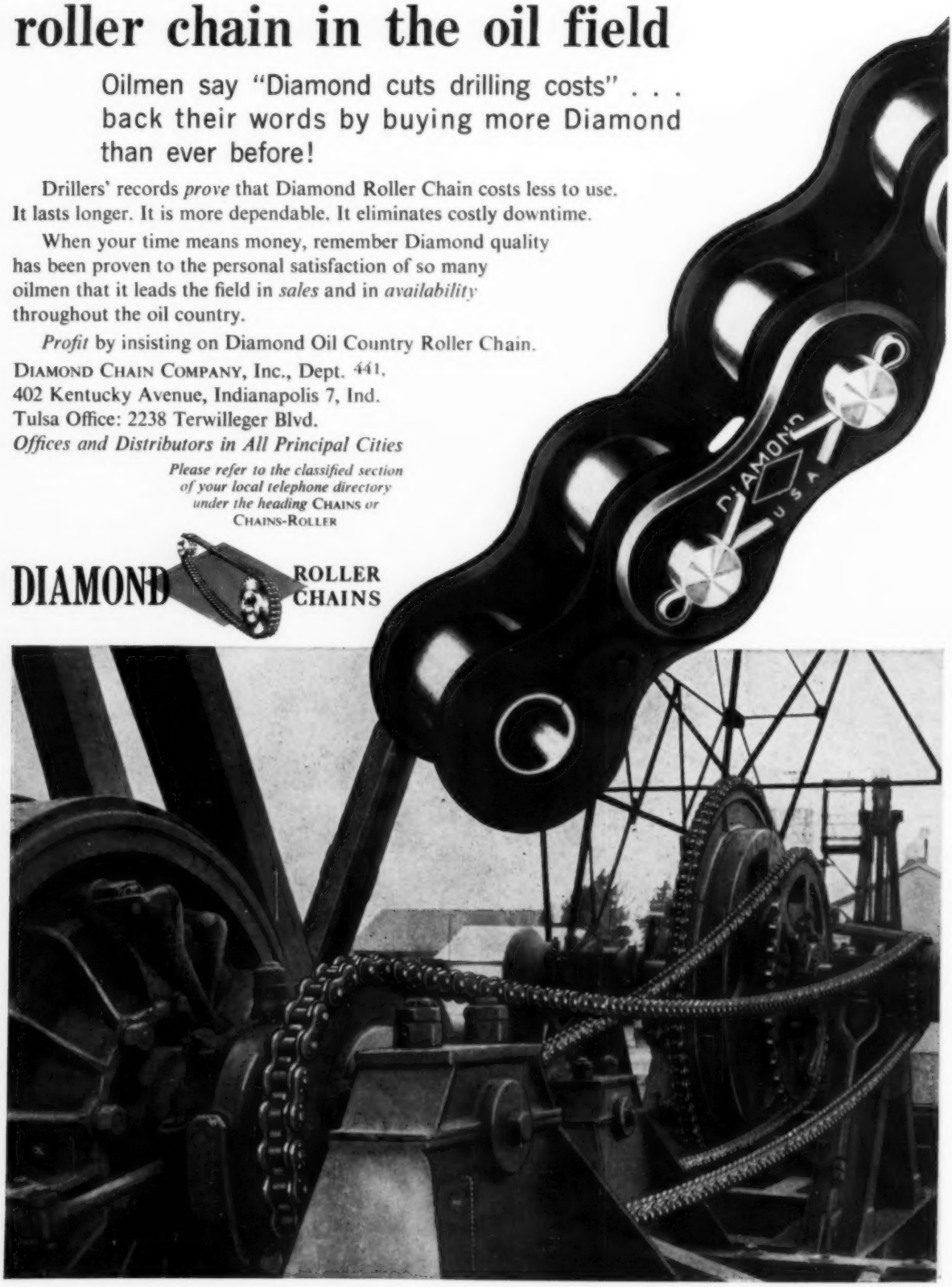
When your time means money, remember Diamond quality has been proven to the personal satisfaction of so many oilmen that it leads the field in *sales* and in *availability* throughout the oil country.

Profit by insisting on Diamond Oil Country Roller Chain.

DIAMOND CHAIN COMPANY, Inc., Dept. 441.
402 Kentucky Avenue, Indianapolis 7, Ind.
Tulsa Office: 2238 Terwilleger Blvd.
Offices and Distributors in All Principal Cities

Please refer to the classified section of your local telephone directory under the heading CHAINS *or* CHAINS-ROLLER

DIAMOND **ROLLER CHAINS**



McEvoy Valves are available in carbon, alloy or stainless steel . . . in ratings to 15,000 p.s.i. working pressure.

five ways . . .

McEVOY valves

enable you to save time and money, increase job safety

1. **safety . . .** McEvoy Valves can be back-seated while packings or bearings are inspected or replaced *under full pressure.*

2. **economy . . .** McEvoy Valves do not require sealing compound just every few times the valves are operated. Large reservoirs within the valves may be filled at *infrequent* intervals, providing money-saving tightness for many, many openings and closings. Thus saving the large portion of the usual maintenance dollar.

3. **trouble-free . . .** Non-wedging gates are not affected by pressure, temperature or line distortions, providing maximum ease of operation.

4. **tightness . . .** the McEvoy self-sealing system stops leaks the instant they start . . . provides *automatic gasketing between gates and seats.* Only McEvoy Valves offer you this outstanding assurance of tightness.

5. **fool-proof . . .** McEvoy Valves cannot be installed backwards. They are *Two-Way valves.* Each valve has two identical, independent sealing systems. Depending on the direction of flow, only the downstream sealing system operates.

McEvoy COMPANY
OIL WELL EQUIPMENT

TEXAS AND MILBY STREETS • P. O. BOX 3127 • HOUSTON 1, TEXAS

Still on the job after 9 years with

MARVEL INVERSE OILER—

Vital Part of World's Finest Engines

The Marvel Inverse Oiler ⟶

is an integral part of the Waukesha NKRU gas unit. Operating off the intake manifold, this completely automatic Oiler feeds Marvel Mystery Oil exactly in proportion to engine loads . . . gives direct protection to the all-important upper cylinder areas.

STILL ON THE JOB after *nine years'* service! This dependable Waukesha NK Series engine, pictured above, has *never* had the head or pan off in all this time.

Like most fine performers, the Waukesha engine is equipped with a Marvel Inverse Oiler for Marvel Mystery Oil—finest performing lubricant on the market.

For engine manufacturers have found that engines equipped with Marvel Inverse Oilers, can be depended upon to give quick acceleration to save trip time . . . keep operating costs to a minimum . . . guarantee hours of continuous performance . . . keep "down time" low by extending periods between overhauls.

The Marvel Inverse Oiler, incorporated as a vital unit in the engine's lubrication system, feeds Marvel Mystery Oil in exact proportion to engine speed and load . . . properly lubricating valves and guides, preventing wear and sticking. It keeps upper piston rings free in their grooves . . . retards ring flutter . . . and cushions ring pounding which can result in ring breakages.

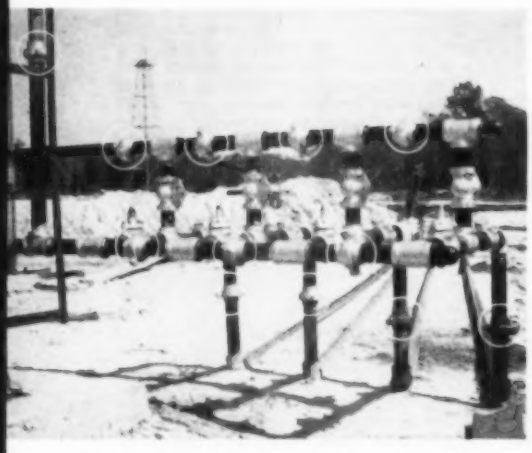
Of course, it is actually the oil that performs these functions and only Marvel Mystery Oil is blended for this purpose and for the Marvel Inverse Oiler!

Available in Canada through Radiator Specialty Company of Canada Ltd., Toronto 2, Ontario, Canada

EMEROL MFG. CO. *242 West 69th Street New York 23, N. Y*

nothing SEALS like a ball... in a precision-ground seat...

that's why WECO unions always form PERFECT SEALS



Years of field service on the toughest jobs, with pressures ranging to 15,000 psi, afford positive proof that nothing seals better than the ball and cone design of WECO Unions. The spherical surface of the male sub always forms a perfect seal against the conical surface of the female sub, providing a secure metal-to-metal seal time after time; a seal that refuses to leak under high pressures, shock, surge or vibration.

WECO Unions are durable as well as efficient. They have stronger subs and wing nuts, heavier wall construction, and sturdy Acme threads. These factors all add up to unions that take the toughest treatment as a matter of course—and come back for more—on hook-up after hook-up.

WECO Unions are available in sizes from 1" through 12", pressures from 1,000 through 15,000 psi—at supply stores everywhere.

U-1-87

WECO®

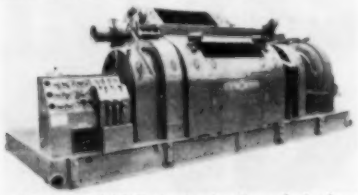
WELL EQUIPMENT MFG. CORP.
HOUSTON, TEXAS

Division of CHIKSAN COMPANY *a subsidiary of*
FOOD MACHINERY AND CHEMICAL CORPORATION

fmc

NEW Drilling and Producing Equipment

New Rig for Electric Application. Development of a series of drilling rigs intended primarily for electric application, Type 1625DE, is announced for drilling in the 16,000 to 25,000-ft depth range. Using 1⅜ or 1½-in. wire line on drawworks it utilizes from 1300 to 2000 hp delivered through electric motor drives.



Type 1625DE is basically of 1-piece design, on a heavy 18-in. beam base, and embodies provision for a sand reel. Rear section accommodates the electric motors. The large drum, 36-in. in diameter and 61¼ in. long, permits hoisting 135-ft stands of drill pipe with 8 lines without spooling more than 3 full layers of line. *National Supply Company.*

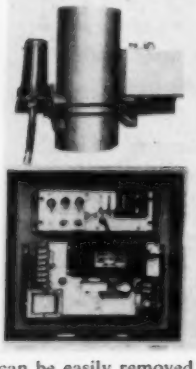
Circle Number (1) on Reply Card.

Airborne Laboratory. An airborne lab contained in a Sikorsky S-55 helicopter, is now being used by Aero Service Corporation in its world wide hunt for additional deposits of ores, rare earths and oil. The helicopter, with its electronic instrumentation, explores in hours ground which formerly took days or weeks to cover.

The aircraft is equipped with 3 separate detecting instruments, each sensitive to a different type of material. The findings of these sensitive instruments are coordinated and recorded on a Brush Electronics Company direct writing oscillograph, which instantaneously charts minute variations in the signals received from the detecting instruments, as well as altitude information from a radio altimeter. *Brush Electronics Company.*

Circle Number (2) on Reply Card.

Density and Gravity Control. A new concept in controlling density and gravity of fluids passing through a pipe either vertically or horizontally is the JSP-173A. A novel feature is that no part of the equipment comes in contact with materials, so that it is not affected by even the most corrosive materials. It requires no drilling of holes or welding of brackets, and can be easily removed for use in another location when desired.



When used with a recorder, it will indicate changes in gravity, interface level of different materials, and solids content in liquids from 1 percent to 25 percent. Recording and controlling devices can be located up to 2000 ft from the material gaging point. *Instruments, Inc.*

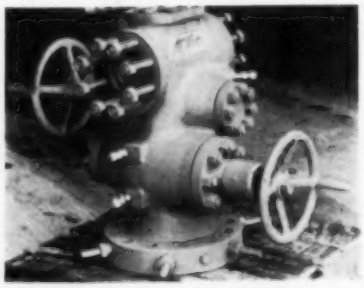
Circle Number (3) on Reply Card.

Abrasion-Resistant Hardfacing. New Spang hardfacing for Spangweld and Spang Double Seal Shrink Thread tool joints is announced by The National Supply Company. Principal feature of this abrasion-resistant hardfacing is uniform distribution of carbide granules, imbedded and bonded in the parent metal of the tool joint to form continuous overlapping protective bands.

Two grades, Spang Banded Medium Density (BMD) and Spang Banded High Density (BHD) with twice as many tungsten carbide granules as BMD, are the results of the close control provided in a newly developed automatic hardfacing process. Standard hardfaced bands are available in widths of 1½ and 3 in. *The National Supply Company.*

Circle Number (4) on Reply Card.

Dual Bore Valve and Dual Tee. The oil industry's first combination dual bore valve and dual tee—2 of the vital components of a dual completion Christmas tree in a single piece of equipment—has been produced by the McEvoy Company. Known as a Type "DVT" Valve (dual valve with integral tee), the unit completely eliminates 1 major flanged connection in a dual completion tree.



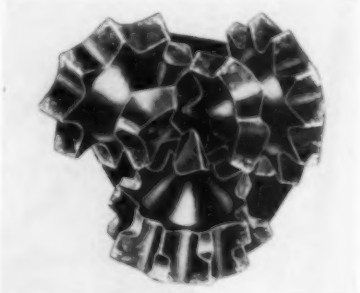
By eliminating this connection, the DVT also eliminates the assembly time, the ring gasket and the studs and nuts necessary to make the connection. More important, a possible source of leakage is avoided. The McEvoy dual valve with tee is available in models engineered to handle 3000, 5000, and 10,000 lb per sq in. of working pressure, in the sizes required by the industry. The 5000 and 10,000 lb WOG models have a flanged top while the 3000 lb WOG equipment is threaded for screw-type top connections. The DVT is full bore for complete vertical access to either tubing string for all wireline operations. *McEvoy Company.*

Circle Number (5) on Reply Card.

Sintered Rod for Fishing Tools. Designers made a big step in the efficiency of fishing tools—mills of all kinds, wash-over shoes, casing cutters—when the use of coarse sintered carbide pieces came into use a short time ago. Stoody Company, is marketing a material known as Composite Rod to meet the specific requirements of fishing tool manufacturers and rebuilders. Rod consists of a nickel-silver matrix containing sharp particles of virgin tool bit grade sintered tungsten carbides. Proportion of carbides varies from 60 to 75 percent. These rods are available from stock and special materials will be made to the specifications of the user on order. *Stoody Company.*

Circle Number (6) on Reply Card.

Soft Rock Bit. Oil Tool Manufacturing Company, Inc., announces their new K-4 bit. To economize the drilling costs per foot over the insert blade bit, this K-4 features a truly advanced tooth design. These long, strong teeth deliver maximum penetration in low compressive strength strata such as soft shales, broken shale,



clays, red beds, salt, shells, and soft limestone. The cones are offset 6 deg from the apex to give a tearing, twisting, gouging action without heavy weights. The K-4 is recommended at weights ranging from 1000 to 3000 psi bit diameter and rotary speeds from 75 to 150 rpm. *Oil Tool Manufacturing Co., Inc.*

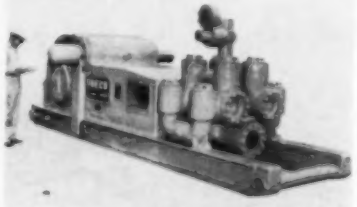
Circle Number (7) on Reply Card.

Magnetic Fuel Shutoff. New Model MV-7199 semi-automatic magnetic fuel shutoff valve with built-in circuit breaker for diesel engines eliminates battery drain after shutdown. Any battery with voltage of 4 to 32 v can be used to close the valve, including the regular engine-starting battery.

Simple to install and wire, valve connects to any Murphy temperature or pressure gage-switch. Specifications include: ¼ in. port; ⅜ in. IPT connections; and machined-brass body. *Frank W. Murphy-Manufacturer, Inc.*

Circle Number (8) on Reply Card.

1250 HP Slush Pump. Designed to meet the modern high pressure requirements of deepest drilling and heaviest duty service, a new 1250 hp Mud-Master duplex slush pump announced by IDECO, features double-row Timken bearings and 20-in. Falk-cut herringbone gears. For a pump of its capacity it has unusual compactness and low weight per horsepower because of the short bearing centers and all-steel fabriform construction.



To assure efficient operation under sustained high pressures, the one-piece normalized steel fluid end has extra thick walls and streamlined passages. With 8-in. liners and at 65 strokes per min the pump will deliver 940 gal per min at 1940 psi. With 6-in. liners it will deliver 495 gal per min at 3680 psi. Stroke is 18-in. Total weight with expendables is 54,788 lb. *Ideco, Inc.*

Circle Number (9) on Reply Card.

Shrinks or Expands Logs. A unique photocopy machine, the RE-CO, is now being applied to well log reproduction and can be used to lengthen or shorten the log scale while maintaining the same horizontal dimensions. This feature has proven most advantageous in highlighting sections of the logs for careful study.

The unit can handle any length of log and also can be used for general photocopy work such as lease records, drawings, run tickets, etc. The process from exposure to finished dried print is accomplished automatically. *Reproduction Equipment Company.*

Circle Number (10) on Reply Card.

Adjustable Linear Bearing. New type ball bearing for linear motion has been developed. Known as Adjustable Diameter Ball Bushings, units are split longitudinally and designed to easily provide line-to-line or slight preload fits when mounted in an adjustable diameter housing. *Thomson Industries, Inc.*

Circle Number (11) on Reply Card.

Teflon Double Seals Valves. A new valve-seating arrangement, employing teflon, that achieves a double seal in valves handling petroleum products ranging from the heaviest viscous fluids to the lightest gases at pressures up to 5000 lb per sq in. has been introduced by W-K-M. Specially designed teflon seat insert is said to double the sealing efficiency of the valves. The first seal occurs when the expanding gate and segment faces of the valve contact the teflon insert. The second seal is made by the gate and segment faces against the metal seat. Teflon inserts are now standard on all oilfield valves through 4 in., rated up to 5000 lb per sq in., and are available for larger size valves. *W-K-M Division, ACF Industries, Inc.*

Circle Number (12) on Reply Card.

Joins Light-Weight Tubing Quickly. A new and economical method of quick coupling thin wall steel and aluminum pipe and tubing has just been introduced by the Victaulic Company of America. Named "Vic-Easy", the new method provides positive, leak-tight connections through the use of quick couplings assembled on Vic-Easy grooved pipe ends.

The "Vic-Easy" method is available for thin wall pipe and tubing in sizes from 1¼-in. to 12-in., and may be used for working pressures up to 1000 psi, depending on the wall thickness of the tubing and type of coupling used. *Victaulic Company of America.*

Circle Number (13) on Reply Card.

Model 200 Recorder. The Mount Sopris transistorized, dual-pen, strip-chart recorder is of the servo driven, self-balancing potentiometer type. This recorder has the following features: (1) An unusual degree of reliability, (2) fast response, 10 mv sensitivity and good linearity, (3) small size and light weight, (4) flexibility.

The manufacturer will make available its engineering staff for help in solving problems in the adaption of the product for any particular use. *Mount Sopris Instrument Corporation.*

Circle Number (14) on Reply Card.

New Line of Thinwall Fittings. The newest thing in thinwall fittings has been introduced to the electrical contractor by Killark Electric, under the name SPEED-OLETS. Aptly named, the new electrical fittings eliminate the need for a wrench, since they can be installed with no more than a screwdriver on the job.

To install, the contractor simply slips the fitting over the conduit and tightens the screw. Made of the same exclusive Killark aluminum alloy, die-cast SPEED-OLETS offer the rust and corrosion resistance long associated with the Killark line. *Killark Electric Mfg. Co.*

Circle Number (15) on Reply Card.

Caterpillar D353 Engine. The D353 engine is available in industrial engine, marine engine, and electric set arrangements. The 6-cylinder, 4-cycle D353 has a 6¼ in. bore and 8 in. stroke, and is rated at 390 (max. output) hp at 1300 rpm.

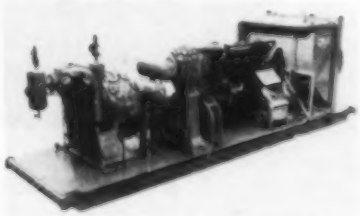
Many of the features incorporated into the engine are the same as those found in the other engines comprising the company's line. Important among them is the Caterpillar fuel system, whose versatility allows operation on a wide variety of fuels without fouling It is designed to operate equally well on No. 2 furnace oil or premium quality diesel fuels. *Caterpillar Tractor Company.*

Circle Number (16) on Reply Card.

Single Cylinder Engine. New 4-cycle single cylinder engine, the Model AGN, rated at 12½ hp has a speed range from 1600 to 3200 rpm and has a piston displacement of 38.5 cu in.

High torque of the unit is 1 of its outstanding characteristics. In addition to the 12½ hp Model AGN, Wisconsin 4-cycle single cylinder engines are supplied in several other sizes ranging from 3 to 9 hp. *Wisconsin Motor Corporation.*

Circle Number (17) on Reply Card.



Air Drilling Package. Two uniquely designed heavy duty portable air drilling units were delivered recently. Although the equipment is heavy duty permanent type, units are completely portable and their compactness allows them to be transported well within road limitations.

One twin cylinder 200 hp compressor is direct-connected to the engine while the other, a single cylinder 100 hp unit, is belt-driven from the same engine. *McNamar Boiler and Tank Company.*

Circle Number (18) on Reply Card.

New Junk Basket. A rugged two-catcher fishing and coring device designed to help make fishing a simple one-trip operation, this junk fishing device uses either a mill-type or flat-bottom-type shoe in connection with 2 sets of free revolving finger-type catchers. Tool will catch all manner of junk which might be broken off or dropped in the hole. It may also be used efficiently for taking core samples, drilling full gage holes and reaming. *Bowen Itco.*

Circle Number (19) on Reply Card.

A Wire Line Oil Saver. Type A Strip-Master has quick change rubbers, instant release and reset, 3000 lb pressure test, and a leak-proof body. The Strip-Master slips over the sinker bar and rope socket. Sturdy wrench lugs allow easy make-up to well fittings. *Bell Rubber Co.*

Circle Number (20) on Reply Card.

Four-Way Valve for 10,000 PSI. This 4-way valve series comes in pipe sizes from ¼ to 1 in. but may be obtained with tube, AND 10050, or any preferred special high pressure connection. It will withstand surges of up to 15,000 psi without damage to the valve's sealing qualities. It is designed for a burst pressure of 30,000 psi. *Barksdale Valves.*

Circle Number (21) on Reply Card.

Extra Strength, Rust Resistance. Two new products offer extra strength and corrosion-resistance in conduit and electrical metallic tubing. Made of famous Yoloy steel, conduit and electrical metallic tubing are designed for use in places where corrosion is more severe than normal.

Soil corrosion studies covering a period of 14 years in 13 different soils show that Yoloy steel pipe has 19 percent less pitting and 36 percent less weight loss than carbon steel pipe, and 10 percent less pitting and 28 percent less weight loss than wrought iron pipe. *Youngstown Sheet and Tube Company.*

Circle Number (22) on Reply Card.

Cleaning and Wrapping Pipe. Dual-purpose line travel cleaning and wrapping machine which consists of a standard CRC cleaning and priming machine with the priming attachment removed has been announced by Crutcher-Rolfs-Cummings, Inc. In its place a wrapping head assembly is universally mounted to the cleaning machine frame. Because of its pivoted attachment, the wrapping head is always perpendicular to the pipe, even on the sharpest bends. Combination cleaning and wrapping by a single unit eliminates the use of extra pipe cradles, side booms, and labor. *Crutcher-Rolfs-Cummings, Inc.*

Circle Number (23) on Reply Card.

Casing Scraper. A new casing scraper, introduced by Gulf Oil Tool Company, removes all foreign material from the bore of the casing and assures full clearance for all tools run in the hole. Tool is considerably shorter than conventional scraping tools due to its having full 360 deg scraping action from a single row of scraping elements.

It is leased to the user for the life of the scraping elements, after which it is returned. *Gulf Oil Tool Company.*

Circle Number (24) on Reply Card.

HALLIBURTON CEMENTING GIVES "ON-SHORE" PROTECTION TO OFFSHORE WELLS

Seagoing oilmen and cementers team up on the toughest of jobs... with onshore effectiveness.

When you call for Halliburton Offshore Cementing Service, specially designed cementing ships carry the same powerful pumps, wide variety of cement, additives and tools... and the kind of experienced cementing crews... that have successfully cemented more wells than any other cementing company in the world.

To be sure of the best in offshore casing and formation protection, call for Halliburton Offshore Cementing Service.

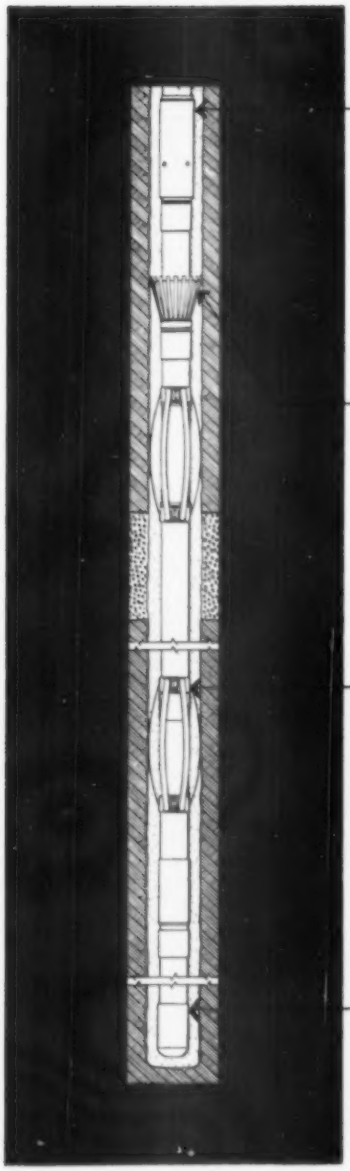
HALLIBURTON

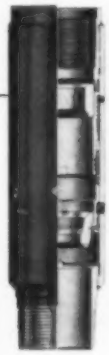
OIL WELL CEMENTING COMPANY

DUNCAN, OKLAHOMA

HIGH COST OF OFFSHORE WELLS MAKES GOOD PROTECTION A MUST

Offshore drilling costs normally run many times higher than other wells and remedial operations are comparably high. Good cementing is a must to protect costly casing and minimize remedial operations. That's why more oilmen call for Halliburton offshore cementing. Here are a few of the tools that help Halliburton's seafaring cementers do an outstanding job.





HALLIBURTON'S "DV" MULTIPLE STAGE CEMENTER

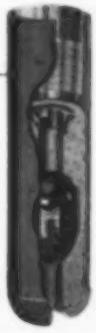
... solves many primary cementing problems encountered in the deeper-than-average holes of coastal and offshore fields. With special plugs and a baffle, two- and three-stage jobs on the same casing string are possible ... in continuous operation or at desired intervals ... using the same or different types of materials in each stage. Designed for positive fluid shut-off by means of hydraulically operated dual sleeves and high-pressure packing.

HALLIBURTON CEMENT BASKETS

... often used below "DV" Multiple Stage Cementer to retain cement and protect weak formations by reducing slurry loss or formation breakdown. Run on outside of casing or liner at point above weak or porous formations. Basket provides bridge, helps support cement column until it takes initial set.

HALLIBURTON'S HEAVY-DUTY CASING CENTRALIZERS

... used in wells offshore where deep directionally drilled holes require extra support for casing. Minimize channeling, aid in uniform placement of cement, thereby reducing later remedial expenses. Hinged for quick installation. Also S-3 centralizers (for average conditions) and Slim Hole types where needed.



SUPER SEAL FLOATING EQUIPMENT

... float shoes and float collars with more than twice the sealing area of usual ball-and-seat valves ... for positive shutoff against back pressure.

SUPER SEAL FLOAT SHOE

CEMENTING SERVICES

OFFSHORE SERVICE ... A SHORT RUN FROM YOUR RIG

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

NEW Literature

For more information on items described here in brief, use the handy reply card and circle the corresponding numbers

New O-Ring Handbook. Parker O-Ring Handbook 5700 thoroughly covers the broad subject of the design and application of synthetic rubber o-ring seals. The book was under preparation for more than 2 years with 18 experts contributing to its contents.

It consists of 160 pages incorporating numerous illustrations, tables, charts and other valuable data. Divided into 9 sections, the book treats such subjects as o-ring applications, compounds and how to select the proper one, engineering data, gland design, installation, static and dynamic seals, military and industrial requirements, o-ring sizes, etc. *Rubber Products Division, Parker Appliance Company.*

Circle Number (25) on Reply Card.

Tractor Shovel. The Yale & Towne Manufacturing Company has issued a colorful 6-page brochure on the 2 cu yd Model 154 Trojan Tractor Shovel. Brochure includes drawings and descriptions of operating benefits such as low load carrying position, independent bucket action, reverse curve safety arms, and straight-line horizontal thrust. Specifications are given, along with a list of standard equipment and optional equipment. *The Yale & Towne Manufacturing Company.*

Circle Number (26) on Reply Card.

Valve Catalog Offered. A new Fairbanks valve catalog, No. 57, covers Fairbanks' complete line of bronze and iron body valves. The 136-page, hard cover catalog includes such recent additions to the Fairbanks' line as the patented renewable seat ring bronze gate valves, composition disc bronze swing check valves and solder end glove valves with drain.

Helpful technical data for the initial design of piping layouts are included in the Useful Information section of the catalog. *Fairbanks Company.*

Circle Number (27) on Reply Card.

Catalog on Grating. New 16-page catalog issued by Borden Metal Products Company gives emphasis to the 3 basic grating types used in construction. Includes dimensional drawings of more than 30 grating subtypes; 8 safeload tables for steel grating, aluminum grating, roadway grating and sidewalk slabs; plus other tables for panel widths, tread widths, floor armor, etc. Various safety treads and nosings are also shown in the catalog as well as detailed instructions for selecting, specifying and ordering grating. *Borden Metal Products Co.*

Circle Number (28) on Reply Card.

Application of V-Belts. In a move related to the petroleum industry's fast-growing importance as a market for its power transmission belt equipment, The Dayton Rubber Company has published an engineering-data catalog on the application of V-belts to oilwell drilling operations.

Titled "Dayton V-Belt Drives for Oil Field Drilling Rigs," the new catalog fulfills a specific need for practical V-belt design recommendations, based on actual drilling operation requirements. The catalog offers pre-engineered drive tables, using every possible sheave combination for slush pump service. *Dayton Rubber Company.*

Circle Number (29) on Reply Card.

Wire Catalog. A 72-page illustrated catalog describing the complete line of CF&I-Wickwire wire has been made available. New catalog gives complete ordering specifications for all CF&I wire including manufacturers low carbon coarse wire, high carbon fine and specialty wire, low carbon fine and specialty wire, and flat and shaped wire. *The Colorado Fuel and Iron Corporation.*

Circle Number (30) on Reply Card.

Jelflake. The way to stop or prevent lost circulation is Dowell's Jelflake. Hundreds of successful applications have been proven using this mixture. All the facts are presented in the new bulletin "Jelflake." *Dowell Incorporated.*

Circle Number (31) on Reply Card.

Check Flange Alignment Accurately. Handy plastic flange gage offered by Rector Well Equipment Company, Inc., is a precision moulded plastic gage calibrated from ⅛ to ⅜ in. It is designed to fit on your key chain.

By inserting the gage around the edge of the flange joint, you can quickly determine if flange faces are lined up evenly and check make-up as flange bolts are tightened. To do a better job in the field, send for your free gage now. *Rector Well Equipment Company, Inc.*

Circle Number (32) on Reply Card.

Barges and Towboats. Ingalls, designers and builders of all types of shallow-draft river equipment, has issued a new brochure which discusses all phases of modern workboat and barge construction. Every Ingalls-built river vessel is especially designed to meet exact requirements, including special built-in loading and discharging facilities. These methods also result in reducing building time and lowering the cost of construction. *The Ingalls Shipbuilding Corp.*

Circle Number (33) on Reply Card.

Submersible Pumps. Johnston submersible pumps are available in 4 in. to 7 in. bowl sizes up to 20 hp with capacities to 375 gal per min. The Johnston submersible pump described in their new bulletin is a complete, packaged series, including the motor, pump unit with built-in check valve on 4 in. units and discharge elbow. A selection table together with important features are also included in this bulletin. *Johnston Pump Company.*

Circle Number (34) on Reply Card.

Rig Drives. The National Supply Company presents in Bulletin 472, a new series of sectional drive groups for consolidated drilling rigs. The bulletin includes features and specifications of the Type B-1¾ Quad. series drive group which was designed more specifically for engines rated above 525 hp, using hydrodynamic drives, and mud pumps at 1000 hp input. *The National Supply Company.*

Circle Number (35) on Reply Card.

Welding Practice. Copies of the 1957 edition of "Recommended Practice for Repair Welding and Fabrication Welding of Steel Castings" is made available by Tempil Corp. This 52-page reference manual represents the first revision of this book since 1951 and contains a considerable amount of newly included material. This booklet is a valuable piece of technical literature. *Tempil Corporation.*

Circle Number (36) on Reply Card.

Valves and Cylinders. Rivett, Inc., has published a folder showing its complete line of valves and cylinders. Two-color folder features the popular models in the 1000 standard Rivett line. Cross-sections illustrate and describe each type of air or hydraulic valve and cylinder.

This helpful brochure has photographs and line drawings of Rivett's keeper ring and tie rod designed cylinders and directional and functional flow valves. Mounting styles and connections, such as pipe, flange or sub-plate mounted are also illustrated. *Rivett, Incorporated.*

Circle Number (37) on Reply Card.

Engineering of Biggest Lift. "The 450 Ton Lift," a new Kelloggram published by The M. W. Kellogg Company, is the fascinating story of the heaviest industrial lift ever accomplished with temporary rigging equipment. It tells in detail how a 450-ton caisson, 314 ft long and 12½ ft in diameter was raised horizontally 152 ft into the air and held in position for 4 weeks. It explains why the lift was the key to the construction of a triangular leg support for the third U. S. offshore Texas Tower radar platform. *The M. W. Kellogg Company.*

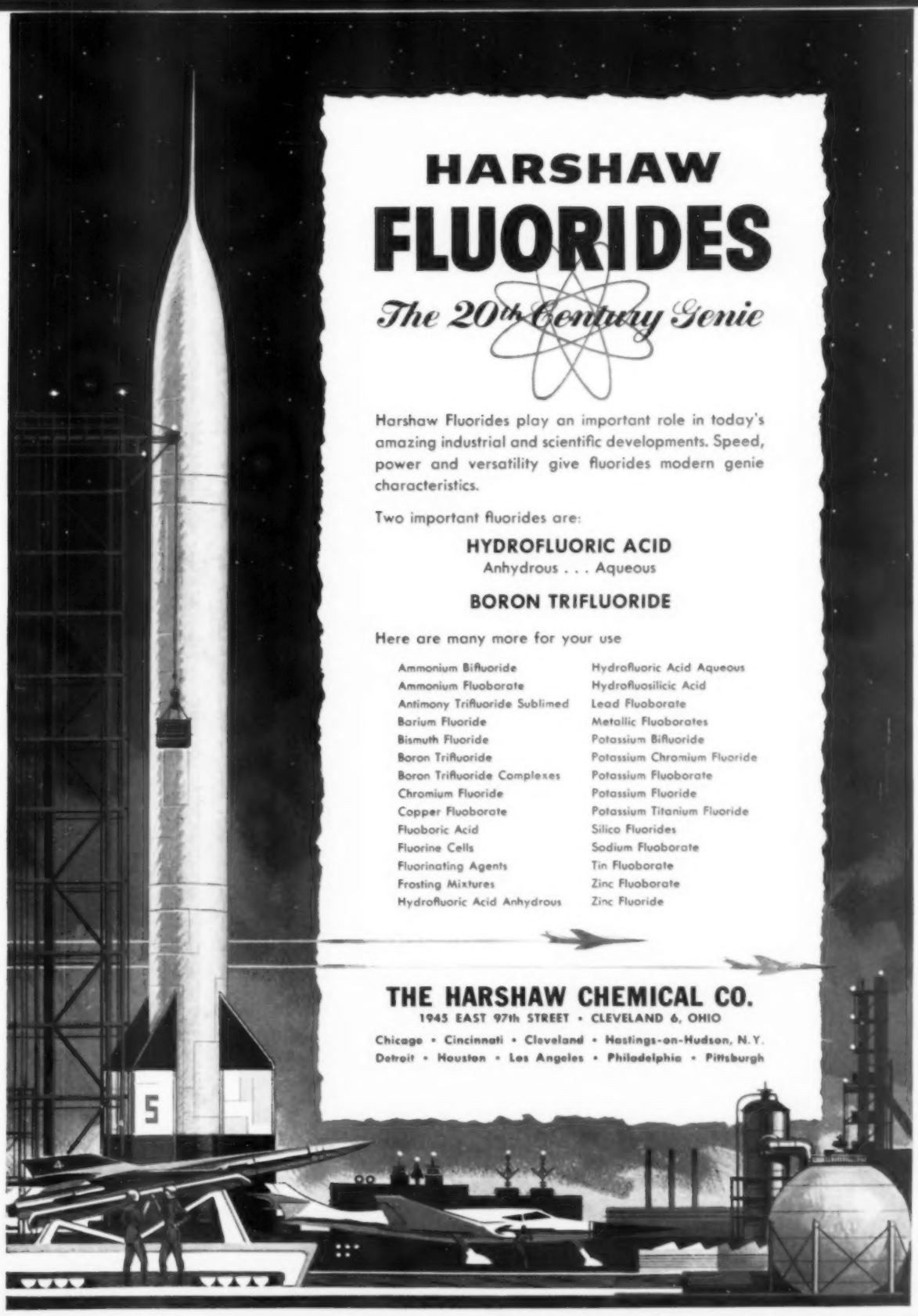
Circle Number (38) on Reply Card.

Spherical Roller Pillow Blocks. New 8-page bulletin describes Spher-Align Pillow Blocks, the most recent addition to Dodge Manufacturing Corporation's full line of mounted bearings. Complete with photographs and engineering drawings, bulletin contains tabulated data on dimensions, shaft sizes, weights and radial load ratings. It explains the new exclusive Micro-Mount, which insures maximum bearing life by providing for fast and accurate seating of bearings on shafts. *Dodge Manufacturing Corporation.*

Circle Number (39) on Reply Card.

Mud Supplies and Services. A complete 1957 catalog of mud supplies and services is available from Baroid Division. An outstanding feature of this catalog is the way in which it discusses Baroid's principal products individually. This catalog contains information of use to every oil man. *Baroid Division, National Lead Company.*

Circle Number (40) on Reply Card.


HARSHAW
FLUORIDES
The 20th Century Genie
Harshaw Fluorides play an important role in today's amazing industrial and scientific developments. Speed, power and versatility give fluorides modern genie characteristics.
Two important fluorides are:
HYDROFLUORIC ACID
Anhydrous . . . Aqueous
BORON TRIFLUORIDE
Here are many more for your use
Ammonium Bifluoride
Ammonium Fluoborate
Antimony Trifluoride Sublimed
Barium Fluoride
Bismuth Fluoride
Boron Trifluoride
Boron Trifluoride Complexes
Chromium Fluoride
Copper Fluoborate
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Vogt GENERAL GP PURPOSE Vogt FOR BETTER VALVES **DROP FORGED STEEL VALVES**

Adv. No. 7 in a series describing the features of Vogt GP Valves.

New Projects in refining gas processing petrochemicals

Cotton Valley Operator's Committee, Louisiana, will extend its plant capacity to recover 50 percent of the available propane in gas it processes, and nearly 100 percent of butanes and heavier. Construction started September 1.

California Oil Company is building a new hexane fractionator to separate 9700 BPD of hexanes, to be sold as commercial solvent. A crude unit is being revamped also. M. W. Kellogg Company is doing the work.

National Petro-Chemicals Corporation will build a $20 million, 75,000,000-lb polyethylene plant for an intermediate density polymer product. Plant should be in operation by late 1958. A modification of the high-pressure process used in the 100,000,000-lb plant at Tuscola, Illinois, will be used to yield a material somewhere between the low-pressure high-density products and the high-pressure material. M. W. Kellogg Company will design and build the plant, location of which has not been decided. Several Gulf Coast sites have been considered. It is known that the plant will be built at a location other than Tuscola.

A natural gasoline plant in the Aneth field, in the Four Corners area will be built by The Texas Company, to be shared in by other companies in that area. Construction starting date, date of completion, capacity, and other statistics have not been announced.

Midland Cooperatives, Inc. has begun construction of a $600,000 lube oil blending plant at Fridley, Minnesota, just north of Minneapolis. To be completed by February 1, 1958, the plant will be built by the Sumner Sollitt Company.

L. Sonneborn Sons, Inc., pioneers in the manufacture of oxidized microcrystalline waxes will expand its facilities for these waxes at its Petrolia, Pennsylvania, refinery. Separate slabbing and packaging facilities will be provided to keep the production separate.

Gulf Oil Corporation has let a contract for the construction of a 10,000 BPD pentane isomerization unit and allied facilities to Procon, Inc., to be built at Gulf's Port Arthur, Texas, refinery. A platinum catalyst will be used. Unusual in the new units is the installation of two huge, "12-story" by 17-ft diam fractionators, which will separate isopentanes, a hexane stream, and a dehexanized stream for cat reformer charge. It is expected that the work will be completed by late 1958.

A new plant to process 150,000,000 cu ft of gas daily will be built by the Wiseco (Wise County) Processing Plant, Inc., near Bridgeport, Texas, to recover 220,000 gal of liquid per day from the gas to be sold to Natural Gas Pipeline Company of America.

Spencer Chemical Company will use the Fauser-Montecatini process in its Henderson, Kentucky, urea plant, which will make 100 tons per day of this product.

Standard Oil Company of California will build a refinery in the Everett, Washington, area by 1960. R. G. Follis, board chairman of Stancal, and nine directors have just made a visit to Vancouver, Washington. Stancal and other refineries expect to process Canadian crudes.

Humble Oil & Refining Company will double its sulfur recovery facilities from refinery gases at Baytown, Texas. Consolidated Chemical Industries Division of Stauffer Chemical alongside, will double its sulfuric acid capacity to handle the added sulfur from Humble.

A 25,000 BPD, $35,000,000 refinery has been authorized by the Philippine Government for construction at Bataan by Standard Vacuum Oil Company.

A 45,000,000-lb ethylene oxide plant is to be built in England by Union Carbide, Ltd., at Fawley, where Esso Petroleum has a refinery to supply ethylene monomer. Final products also will include glycols, polyethylene ethers, ethanolamines, glycol ethers, and other specialties. The same company will complete a 24,000,000-lb per year polyethylene plant at Grangemouth, in October 1957.

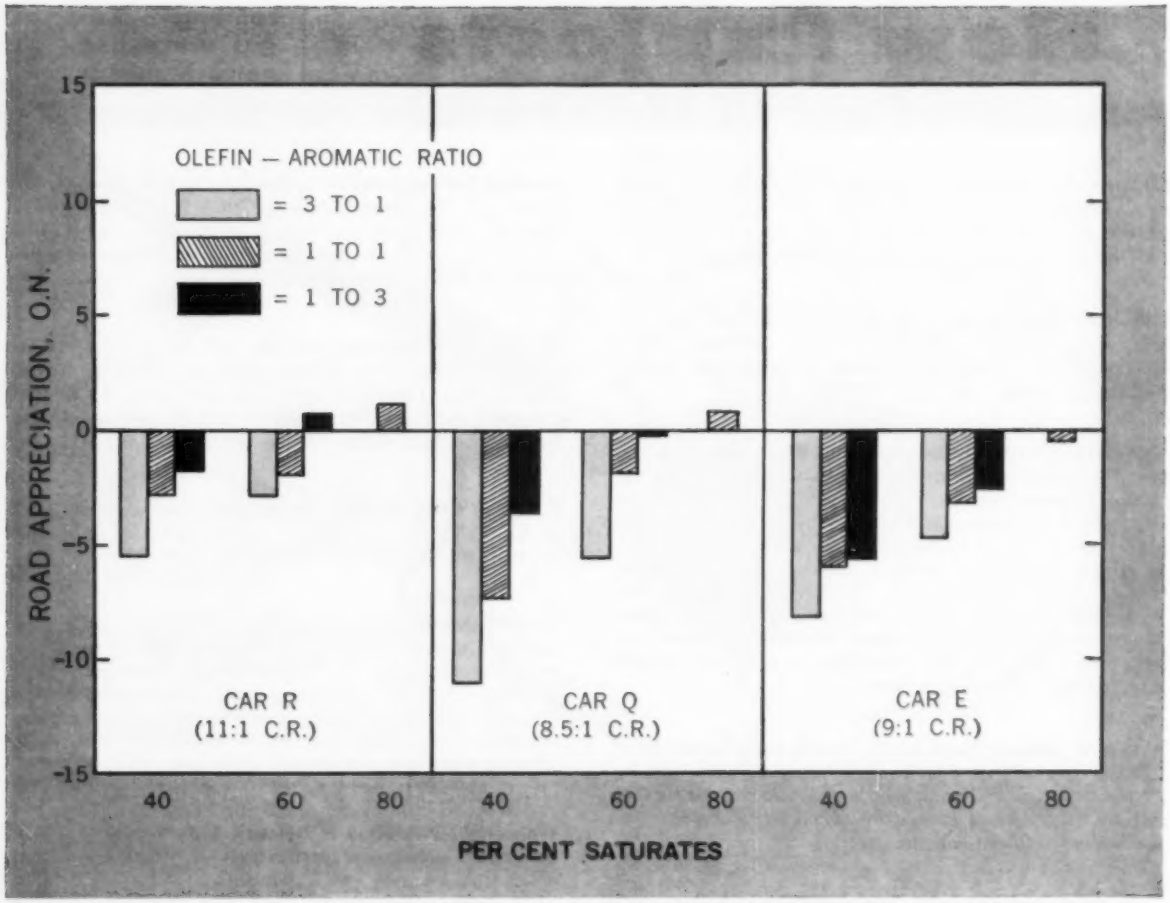
Wainwright Producers & Refiners, Ltd. will build several new units, including a thermal cracker, a cat reformer, a desulfurization unit, and a polymerization unit at its 4500 BPD Wainwright, Alberta, plant. The units are to be designed by Ralph M. Parsons Company.

Construction of the British-American Oil Company refinery at Moody, British Columbia, Canada, is getting under way with M. W. Kellogg doing the designing and building. Crude unit capacity will be 20,000 BPD; other units will include vacuum distillation, a 9000 BPD fluid cat cracker, and catalytic reforming, alkylation, and hydro-desulfurization units. Completion will be in late 1958.

Cities Service Oil Company, Ltd., will build its Canadian refinery at Bronte, Ontario, to cost $27,000,000 and reach completion in January 1959. Capacity is 20,000 BPD, with crude to come via the Interprovincial Pipe Line, from Alberta fields. The company is expanding its marketing facilities in Canada, will be fully integrated by early 1959, and is increasing its exploration and drilling activities.

The Italian Company ANIC has contracted with the Societe Belge De L' Azote, etc., for design and construction of a styrene monomer plant of 14,000 annual tons capacity at Ravenna, Italy. Styrene will be used to make synthetic rubber, and the plant will use the process by Koppers Company, Inc., Pittsburgh, Pennsylvania.

An 80,000 BPD British Petroleum Company refinery will start building later this year, and be finished by 1960 in the German Ruhr area. It will cost $83,000,000.



Effect of hydrocarbon-type concentration on the road appreciation of leaded blends containing three hydrocarbon-types. Tests at 3000 RPM were made in two 1955 cars of conventional engine compression ratio and in one experimental model of 11-to-1 compression ratio

Ethyl Research Offers Refiners New Benchmark in Rating Gasoline Test Blends

Road Performance Predicted From Laboratory Data

BY F. D. BUERSTETTA, Refinery Technology Division, Ethyl Corporation Research Laboratories

A CONTINUING research program in Ethyl Corporation's Detroit Laboratories has produced new data that will assist refiners in blending their fuels for optimum road performance.

These data are available in a published report entitled, "Road Performance of Ternary C_7-C_8 Hydrocarbon Blends." It is the fifth in a series of progress reports on the program which is aimed at gaining a more thorough understanding of the principles relating gasoline hydrocarbon composition to road antiknock performance.

In this latest report, consideration of the effects of hydrocarbon-type concentration in various blends containing three hydrocarbon types in the C_7-C_8 range at two tetraethyllead concentrations forms the basis for discussion.

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Binary Blend Testing Preceded Ternary Blend Studies

All four previous reports were based on the road antiknock behavior of 99 blends, each of which contained two types of pure hydrocarbons in the C_7-C_8 range.

These blends, composed of toluene and diisobutylene separately added to mixtures of isooctane and n-heptane, were extensively tested to find the relationships that exist between road performance and the fuel variables commonly defined by laboratory tests:

Hydrocarbon type and concentration, Research and Motor octane number, and TEL concentration.

An Ethyl Corporation Research team evaluates data obtained in the most recent study of the relationship of fuel variables to road performance.

The program's scope included numerous combinations of hydrocarbon concentration and TEL content at the Research octane levels of 92, 96 and 100, thus permitting several different approaches to the data analysis.

Blends considered in this most recent phase of the program also were of toluene and diisobutylene, representing aromatics and olefins respectively in saturate mixtures of isooctane and n-heptane.

These components were combined to give ternary blends containing 40, 60 and 80% saturate concentration with olefin-to-aromatic ratios of 1-to-3, 1-to-1, and 3-to-1 at each saturate level.

A nominal Research octane number level of 100 was maintained for all blends at TEL concentrations of 0.0 and 3.0 ml per gallon.

In order to provide comparisons with the binary blend studies, road ratings were conducted in the same 1955 passenger cars that were used in previous tests, (nominal compression ratios of 9.0-to-1 and 8.5-to-1).

The blends also were rated in a car having an 11-to-1 compression ratio engine to permit evaluation of performance in engines of the future. All data were interpreted in terms of "road appreciation" to give refiners a better idea of the effectiveness of each blend.

New Tests Confirm Earlier Conclusions

Test results of blends containing three hydrocarbon-types verified the previous conclusions based on binary blend studies — that hydrocarbon-type and concentration, Research and Motor octane number, and TEL level are the most important factors affecting the road performance of gasoline.

Analyses of test data produced these conclusions:

1. The addition of TEL from 0.0 to 3.0 ml per gallon significantly increased road appreciation in all cars over the speed range. This effect is greatest at high engine speed.

2. TEL generally has the greatest effects in fuels containing highest aromatic and saturate percentages.

3. Increasing aromatic content at constant saturate level results in increased road performance of the ternary blends in all cars.

4. With regard to road appreciation, the ternary blends vary—as did the binary blends—according to changing aromatic (or olefin) percentages.

5. Road appreciation is also related qualitatively to fuel sensitivity.

6. The hydrocarbon-type effect is most notable at high engine speeds in all of the test cars.

Results of the long-range program are made available to the refiner as the data are analyzed and reported.

Over-all Research Program Continues

These research findings are but another step forward in Ethyl's continuing effort to aid the refiner in blending fuels and predicting road performance without extensive road testing.

Right now, the long-range program is being carried forward to include all of the hydrocarbons falling within the gasoline boiling range. The results obtained in this important phase of the program will be made available for study by refiners in the near future.

How Ethyl Research is helping you

At today's high octane levels, the art of blending hydrocarbons has taken on ever-increasing importance. As a service to the Petroleum Industry, Ethyl Research launched its long-range hydrocarbon blending program in 1956 to complement the intensive Industry effort being devoted to the problem.

Since the program started, Ethyl has made available four technical reports: "Octane Possibilities with C_7-C_8 Hydrocarbons," "Octanes That Count," "TEL, Hydrocarbons and Road Appreciation," and "Road Performance of C_7-C_8 Blends via Computer Analysis."

Now a fifth report, "Road Performance of Ternary C_7-C_8 Hydrocarbon Blends," is available for your study. Copies of this—and any of the previously issued reports—can be obtained from your Ethyl Representative or by writing Ethyl Corporation, 100 Park Avenue, New York 17, N. Y.

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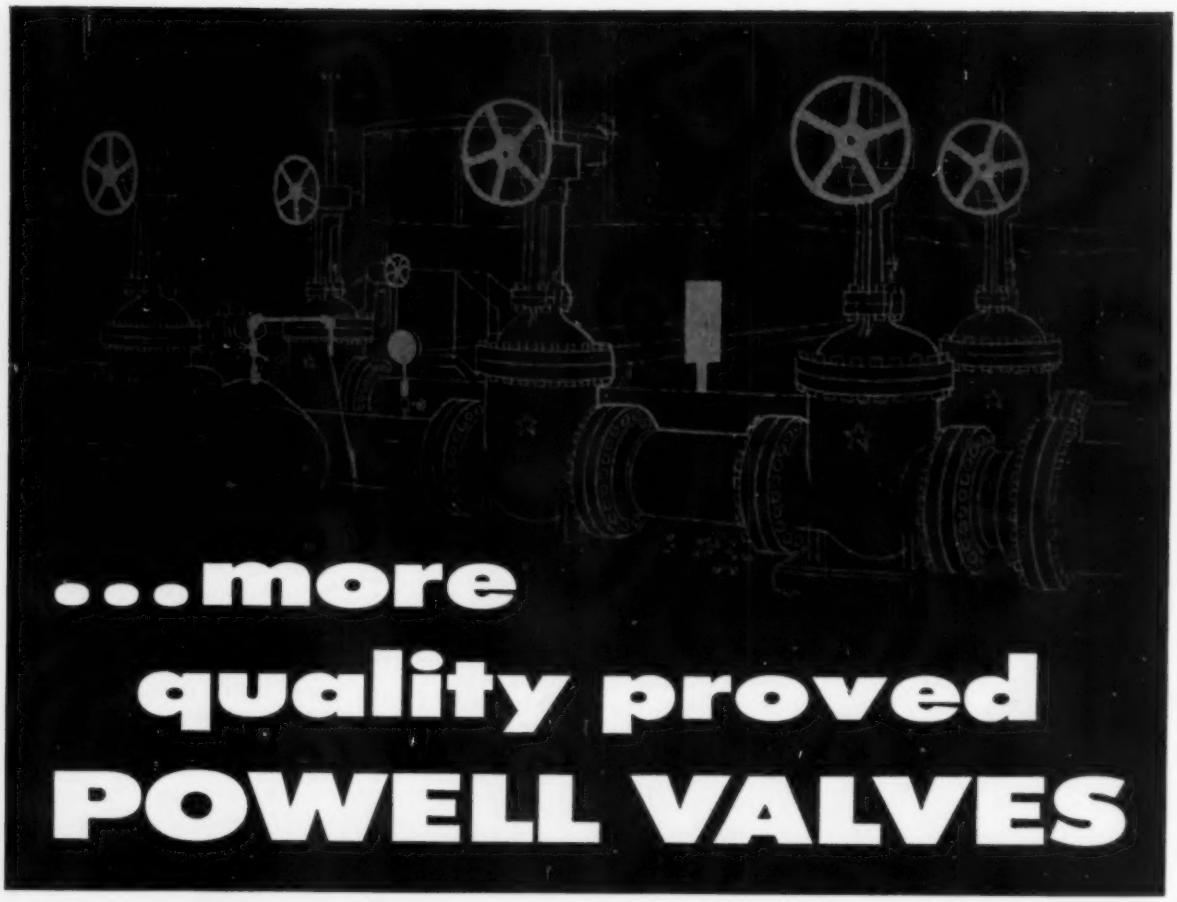

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Fig. 3059G—300-Pound Steel Lubricated Plug Valve. Bolted Gland type. Gear Operated. Sizes 6" to 12".

Fig. 2467—Small Stainless Steel Gate Valve for 300 Pounds W.P. Outside screw stem and bolted yoke.

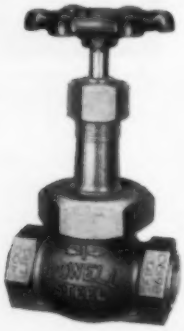

Fig. 86190—Steel "LPG" Globe Valve for 400 W.O.G. For services that demand the use of Steel Valves.

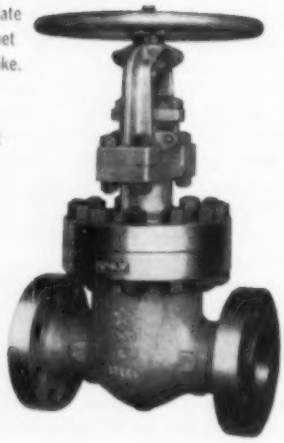

Fig. 1303—1500-Pound Steel Gate Valve with bolted flanged bonnet and outside screw stem and yoke.

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DESIGN HANDBOOK

How to Design Finned Tube Shell and Tube Heat Exchangers

		PART	
➧	Fundamentals of Finned Tube Heat Transfer	1	• *Basic heat transfer relationships; example problems*
	Design of Finned Tube Condensers	2	• *Selection and sizing of equipment for hydrocarbons and other organic compounds*
	Design of Finned Tube Heaters and Coolers	3	• *Design relationships; liquid-liquid cooler sample problems; economics of finned tube exchangers*
	Design of Finned Tube Partial Condensers	4	• *Rigorous and approximate methods; how to design for saturated and superheated feeds*

Edwin H. Young, *Associate Professor*
and
Dennis J. Ward, *Wolverine Trufin Fellow*

Department of Chemical and Metallurgical Engineering
University of Michigan
Ann Arbor, Michigan

INTEGRAL finned tubes can be used to advantage in certain shell and tube heat transfer applications. Finned tube bundles of the type shown in Fig. 1 are becoming widely used in shell and tube heat exchangers. As indicated in Fig. 2 the tube has a plain end for expanding into tube sheets of standard heat exchangers. Heat exchangers for certain applications can be designed so as to take advantage of the extended surface and many existing units can be retubed for the same purpose. The problem of how to determine when finned tubes can be used to advantage is the subject of this series of articles on the use of finned tubes in shell and tube applications. This first article is concerned with the fundamental heat transfer relationships for determining the required finned tube heat transfer area for shell and tube units. Later articles are concerned with the determination of shell side (fin) coefficients and design of condensers, coolers, and partial condensers. Economic considerations play an important part in determining whether or not finned tube units should be used.

A four part series of articles by D. A. Donohue[1] presents an excellent survey of the different types of exchangers, their heat transfer characteristics (for bare tubes), fluid flow and mechanical design. In recent years a number of investigators have published the results of research work on finned tubes.[3-16]

The determination of the applicability of finned tubes for a particular service involves the use of ordinary heat transfer considerations plus an understanding of the effect of the fin on the performance of the tube. The basic heat transfer relationship prescribed by the Standards of Tubular Exchanger Manufacturers Association[2] for bare tube surfaces can be modified for extended surface tubes.

Bare Tubes

Equation 1 gives the fundamental relationship for determining the required outside heat transfer tube surface area,

$$A_o = \frac{Q}{U_o \Delta t} \quad \ldots\ldots \quad (1)$$

in which:

A_o = required external surface area, sq ft,
Q = total heat to be transferred, Btu per hr,
Δt = the proper mean temperature driving force, and
U_o = overall service coefficient of heat transfer, Btu per (hr) (F) (sq ft of outside surface area).

The overall coefficient of heat transfer U_o for bare tubes is further defined as:

$$U_o = \frac{1}{\frac{1}{h_o} + r_o + r_w\left(\frac{A_o}{A_m}\right) + r_i\left(\frac{A_o}{A_i}\right) + \frac{1}{h_i\left(\frac{A_i}{A_o}\right)}} \quad \ldots \quad (2)$$

in which:

h_o = shell side coefficient of fluid medium on outside of tubing,

r_o = fouling resistance on the outside of the tubing,

r_w = resistance of the tube wall (root wall in the case of finned tubes) = X/k,

r_i = fouling resistance on the inside of tubing,

h_i = film coefficient of the fluid medium on inside of tubing,

A_m = mean heat transfer area of metal wall, and

$\left(\frac{A_o}{A_i}\right)$ = the ratio of outside tube surface to inside tube surface.

Finned Tubes

Equation 1 can also be used for determining the required external surface area for finned tube bundles. Equation 2 which defines the overall coefficient of heat transfer for bare tubes also may be used for finned tubes if the outside coefficient, h_o, and outside fouling resistance, r_o, are modified so as to include the efficiency of the finned surface.

The inside film coefficient, h_i, for finned tubes is determined in the same manner as for ordinary bare tubes.

TEMA* fouling factors[2] are used for the inside surface fouling. The resistance of the root wall of a finned tube can be computed in the usual manner since the resistance of the fin is taken care of separately. The remaining terms r_o and h_o involve the performance of the fin.

Fouling tests reported by Katz, et al.,[3] indicate that the fouling factors on the outside of finned tubes are about the same as for bare tubes and that solution cleaning of fouled finned tubes can restore heat transfer to its initial condition. Additional finned tube fouling data have been published by Armstrong[4] and by Ames and Newell.[5] The usual normal fouling factors of TEMA[2] can therefore be used with integral helical finned tube surfaces.

The determination of the fin side coefficient has been the subject of a number of papers.[6-16] Gardner has presented fin efficiency curves for several forms of straight fins, annular fins, and spines.[17] Dusinberre has shown that the fin efficiency curves of Gardner can be approximated in simple algebraic form (in the high efficiency region).[18] The fin extends out into the fluid stream and as a result has a "skin" temperature that lies somewhere between the root wall outer surface temperature and the fin side fluid "bulk stream" temperature.

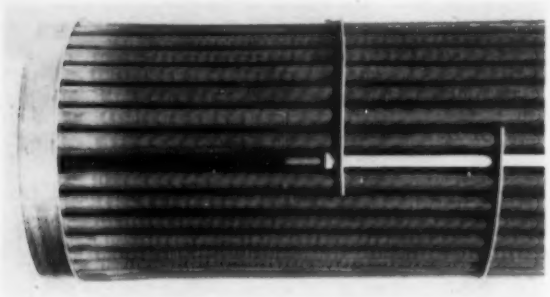

FIG. 1. Typical finned tube bundle.

The fin efficiency Φ is defined as:

$$\Phi = \frac{q \text{ (actual at } \Theta)}{q \text{ (if at } \Theta_b)} = \frac{t_{bs} - t_{mf}}{t_{bs} - t_{mr}} \quad . \quad . \quad (3)$$

where

q = actual heat transferred through the fin,

q (at Θ_b) = the heat that would have been transferred if the fin surface temperature was at the root wall (or base of fin) temperature,

Θ = (temperature of bulk stream — temperature of metal fin), and

= $(t_{bs} - t_{mf})$,

Θ_b = (temperature of bulk stream—temperature of metal root), and

= $(t_{bs} - t_{mr})$.

Dusinberre's relationship for a circumferential fin having a rectangular cross section is:

$$\Phi = \frac{1}{1 + \frac{m^2}{3}\sqrt{\frac{D_o}{D_r}}} \quad . \quad . \quad . \quad . \quad . \quad (4)$$

where

$$m = H\sqrt{\frac{2}{\left(\frac{1}{h'_o} + r'_o\right) K_m Y}} \text{ (dimensionless)}$$

*TEMA = Tubular Exchanger Manufacturers Association.

where

H = fin height = $(D_o - D_r)/2$,

h'_o = actual fin side coefficient,

r'_o = TEMA fouling resistance on outside of fin tubing,

K_m = thermal conductivity of fin metal,

Y = fin thickness,

D_o = diameter over the fin, and

D_r = root diameter.

The factors that affect the skin temperature of the fin and the fin efficiency are:

1. Fin material *(thermal conductivity of fin metal).*
2. Fin thickness *(if the thickness of a fin is increased, the fin temperature tends to approach the tube root wall temperature rather than the bulk stream temperature).*
3. Fin height *(if the height of the fin is increased, the fin tends to approach the bulk stream temperature with a loss in temperature driving force).*
4. Film coefficient *(as the film coefficient rises the fin temperature approaches the bulk stream temperature).*
5. Shape of fin.
6. Fouling on the fin side.

Fig. 3 presents the values of fin efficiency as a function of the outside heat transfer coefficient h'_o and outside fouling resistance r'_o for 19 fin-per-in. tubes of the type shown in Fig. 1 and 2.

The fin efficiency is simply a correction factor which must be included in the design to account for the fact that the temperature drop across the fin film coefficient is different than that across the root surface coefficient. This can be illustrated in the following manner. Let

$$Q_t = Q_f + Q_r \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

where

Q_t = total heat transferred,

Q_f = heat transferred thru fin, and

Q_r = heat transferred thru prime metal (root metal).

Considering a clean outside surface,

$$Q_f = h'_o A_{fin} (t_{bs} - t_{mf}) \quad . \quad . \quad . \quad . \quad . \quad (6)$$

and

$$Q_r = h'_o A_{root} (t_{bs} - t_{mr}) \quad . \quad . \quad . \quad . \quad . \quad (7)$$

where

t_{bs} = temperature of bulk stream,

t_{mf} = temperature of fin metal surface,

t_{mr} = temperature of root metal surface, and

h'_o = actual fin side coefficient.

But

$$(t_{bs} - t_{mf}) = \Phi (t_{bs} - t_{mr}) \quad . \quad . \quad . \quad . \quad . \quad (8)$$

therefore

$$Q_f = h'_o A_{fin} (t_{bs} - t_{mr}) \Phi \quad . \quad . \quad . \quad . \quad . \quad (9)$$

and

$$Q_t = h'_o A_{root} (t_{bs} - t_{mr}) + h'_o A_{fin} (t_{bs} - t_{mr}) \Phi \quad . \quad . \quad . \quad . \quad . \quad (10)$$

An examination of Equation 10 indicates that a choice exists in the application of the fin efficiency Φ. The fin efficiency can be considered to either (a) reduce the temperature difference $(t_{bs} - t_{mr})$, (b) reduce the fin area, A_{fin}, or (c) reduce the fin side coefficient, h'_o. All three interpretations are used and are of course equally correct. Another alternate design procedure consists of combining the fin efficiency Φ of the fin with the 100 percent efficiency of the root by taking a weighted average based on the rela-

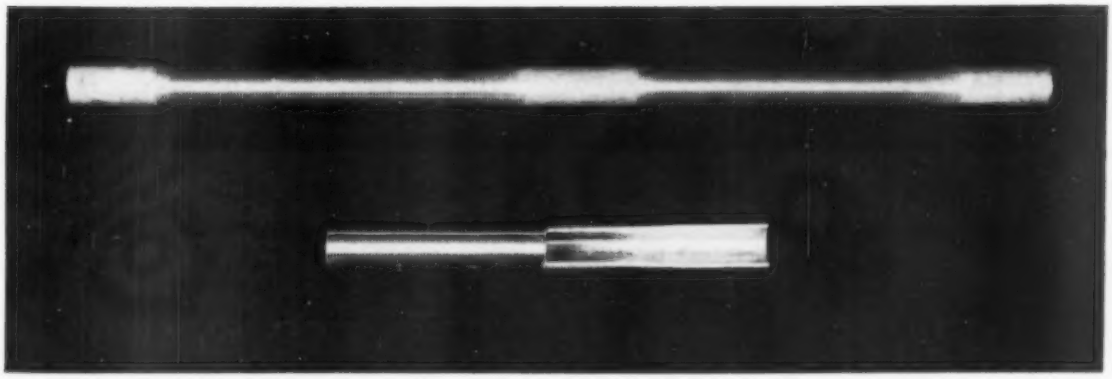

FIG. 2. Section of an integral low-finned tube.

tive fin and root areas and reducing the effective film coefficient, h'_o, by this amount after having factored out the h'_o in Equation 10. This method is used by Mack and Pitcher[19] and Skiba.[20] Two other alternate methods currently in use are presented below; one is based on the application of fin efficiency to the fin area to give an equivalent area and the second is based on a modification of the fin resistance method of Carrier and Anderson.[21]

Equivalent Area Method

Equation 10 can be factored to give the following relationship:

$$Q_t = h'_o\,(A_{root} + \Phi\,A_{fin})\,(t_{bs} - t_{mr}) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (11)$$

or

$$Q_t = h'_o\,A_{eq}\,(t_{bs} - t_{mr}) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (12)$$

where

$$A_{eq} = A_r + \Phi\,A_{fin} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (13)$$

The equivalent area, A_{eq}, and actual fin side coefficient, h'_o, are related to the total outside area, A_o, and the design coefficient h_o as follows:

$$h_o A_o = h'_o A_{eq} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (14)$$

The design coefficient h_o can be determined by solving Equation 14 for h_o to give:

$$h_o = h'_o\left(\frac{A_{eq}}{A_o}\right) \quad . \quad . \quad . \quad . \quad . \quad . \quad (15)$$

The ratio $\frac{A_{eq}}{A_o}$ given in Equation 15 is the "weighted efficiency" used by Skiba.[20] For convenience the ratio $\frac{A_{eq}}{A_o}$ can be plotted in advance for any tube as follows. Dividing Equation 13 by A_o gives:

$$\frac{A_{eq}}{A_o} = \frac{A_r}{A_o} + \Phi\,\frac{A_{fin}}{A_o}$$

A plot of $\frac{A_{eq}}{A_o}$ using this relationship for tubes of the type shown in Fig. 1 and 2 is presented in Fig. 4.

The fouling resistance r_o in Equation 2 is defined as:

$$r_o = r'_o\left(\frac{A_o}{A_{eq}}\right) \quad . \quad . \quad . \quad . \quad . \quad . \quad (16)$$

where r'_o = TEMA Fouling Resistance. The value of h_o from Equation 15 and the value of r_o from Equation 16 can be substituted directly into Equation 2 and the overall coefficient U_o determined. Substitution of U_o into Equation 1 gives the required external finned tube heat transfer area A_o. An illustration of this procedure is presented following a discussion of the Fin Resistance Method.

Fin Resistance Method

Carrier and Anderson presented the fin resistance method for handling fin efficiency for the case of non-fouled fins in 1944.[21] The resistance of a non-fouled fin is defined as:

$$r_f = \frac{1}{h_o} - \frac{1}{h'_o} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (17)$$

where r_f = resistance of the fin.

A relationship including fin efficiency which relates h_o and h'_o is given by Equation 15 in which the definition of A_{eq} is given by Equation 13. If Equation 13 is substituted into Equation 15 and Equation 15 is substituted into Equation 17 for h_o, the following relationship of Carrier and Anderson is obtained,

$$r_f = \frac{1}{h'_o}\left[\frac{1-\Phi}{\frac{A_r}{A_f} + \Phi}\right] \quad . \quad . \quad . \quad . \quad . \quad (18)$$

It can be shown that if the fin surface is fouled Equation 17 must be modified to include the fouling resistance as follows:

$$r_f = \left[\frac{1}{h'_o} + r'_o\right]\left[\frac{1-\Phi}{\frac{A_r}{A_f} + \Phi}\right] \quad . \quad . \quad . \quad (19)$$

where r'_o = TEMA outside fouling resistance.

To use the fin resistance method in design applications, Equation 2 must be rewritten in the following form:

$$\frac{1}{U_o} = \frac{1}{h'_o} + r'_o + r_f + r_w\left(\frac{A_o}{A_m}\right) + r_i\left(\frac{A_o}{A_i}\right) + \frac{1}{h_i}\left(\frac{A_o}{A_i}\right) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (20)$$

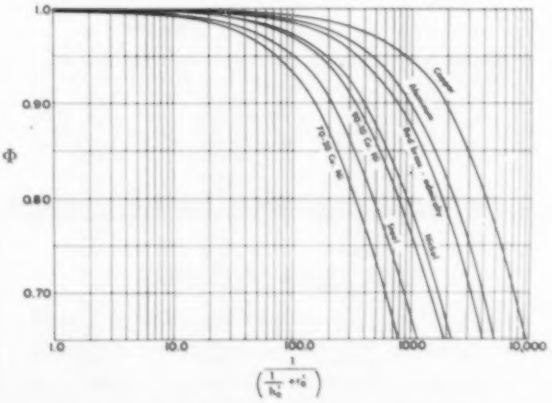

FIG. 3. Fin efficiency of 19-fin-per-in. low-finned tubes.

in which

h'_o = actual film coefficient of fluid medium on outside of finned tubing,

r'_o = TEMA fouling resistance on outside of finned tubing,

r_f = resistance to the fin (see Equation 19),

r_w = resistance of root wall,

r_i = fouling resistance on the inside of the tube,

h_i = film coefficient of fluid medium on the inside of tubing, and

$\left(\frac{A_o}{A_i}\right)$ = ratio of outside tube surface to inside tube surface.

Equation 4 can be substituted into Equation 19 to give:

$$r_f = \left[\frac{1}{h'_o} + r'_o\right]\left[\frac{\frac{m^2}{3}\sqrt{\frac{D_o}{D_r}}}{1 + \frac{A_r}{A_f}\left(1 + \frac{m^2}{3}\sqrt{\frac{D_o}{D_r}}\right)}\right] \quad . \quad (21)$$

For given values of h'_o and r'_o the fin resistance r_f can be directly determined for a particular finned tube by use of Equation 21. Table 1 gives the dimensions of typical 19-fin-per-in. low finned tubes. The fin resistance r_f corresponding to various values of $\left[\frac{1}{h'_o} + r'_o\right]$ are given in Table 2 for a ¾-in. admiralty tube.

TABLE 2. Fin Resistance of ¾ In. 19 Fin-Per-In. Admiralty Tube.

$\left[\frac{1}{\frac{1}{h'_o} + r'_o}\right]$	r_f
0	.00011280
10	.00011277
20	.00011274
50	.00011264
100	.00011248
200	.00011217
500	.00011123
1000	.00010971
2000	.00010679

An examination of Table 2 indicates that the fin resistance of this tube is relatively constant over the usual range of fin side coefficients encountered in finned tube applications. Fig. 5 presents the variation in fin resistance of 19 fin-per-in. tubes. An illustration of the use of the fin resistance method of design is presented under Example Calculations.

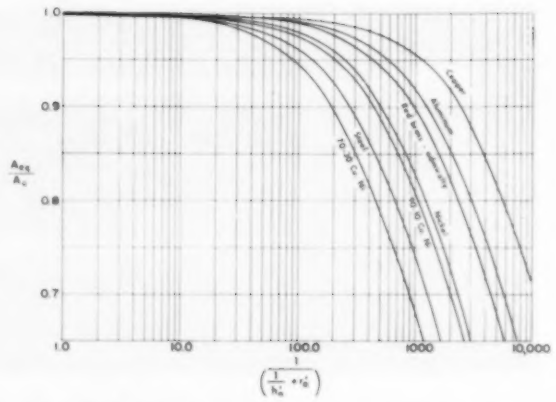

FIG. 4. Ratio of A_{eq} to A_o for 19-fin-per-in. low-finned tubes.

Example Calculations

Illustrations of the use of the equivalent area and fin resistance methods for the determination of U_o for a distillate cooler using ¾ in. 19 fin-per-in. admiralty tubes are presented as follows:

TABLE 3. Distillate Cooler Heat Transfer and Fouling Resistances.

Film Coefficients	
h'_o, distillate film coefficient*	200
h_i, water film coefficient	1000
r'_o, fin side fouling resistance	0.001
r_i, tube side fouling resistance	0.001

*The determination of fin side film coefficients is the subject of succeeding articles in this series.

Solution:

A. By The Equivalent Area Method

This method involves the use of Equations 2, 13, 15, and 16 and the determination of fin efficiency. Equation 4 indicates that the fin efficiency is a function of:

$$m = H\sqrt{\frac{2}{\left(\frac{1}{h'_o} + r'_o\right)K_m Y}}, \text{ and } \left(\frac{D_o}{D_r}\right)$$

Substituting the tube dimensions (from Table 1) and the

TABLE 1. Typical Dimensions of Selected 16 Gage Wall, 19-Fin-Per-In., Finned Tubing.*

Nominal O D (in.)	Alloy	Plain Ends: O D in.	Plain Ends: Wall Thickness in.	Finned Section: O D of Fins in.	Finned Section: Root Dia. in.	Finned Section: Wall Thickness in.	A_o sq ft/ft	A_o/A_i
⅝	Copper	0.625	0.071	0.614	0.499	0.065	0.405	4.19
⅝	Cu-Ni	0.625	0.072	0.614	0.499	0.065	0.405	4.19
⅝	Admiralty	0.625	0.077	0.612	0.515	0.065	0.386	3.80
⅝	Nickel	0.625	0.077	0.612	0.515	0.065	0.386	3.80
¾	Copper	0.750	0.077	0.739	0.624	0.065	0.496	3.84
¾	Cu-Ni	0.750	0.077	0.739	0.624	0.065	0.496	3.84
¾	Admiralty	0.750	0.082	0.737	0.640	0.065	0.438	3.39
¾	Nickel	0.750	0.082	0.737	0.640	0.065	0.438	3.39
⅞	Copper	0.875	0.083	0.864	0.749	0.065	0.588	3.63
⅞	Cu-Ni	0.875	0.082	0.864	0.749	0.065	0.588	3.63
⅞	Admiralty	0.875	0.087	0.862	0.765	0.065	0.520	3.12
⅞	Nickel	0.875	0.087	0.862	0.765	0.065	0.520	3.12
1	Copper	1.000	0.083	0.989	0.874	0.065	0.678	3.48
1	Cu-Ni	1.000	0.082	0.989	0.874	0.065	0.678	3.48
1	Admiralty	1.000	0.082	0.987	0.890	0.065	0.598	3.01
1	Nickel	1.000	0.082	0.987	0.890	0.065	0.598	3.01

*Mean fin thickness is about 0.015 in., $A_f = 0.8\ A_o$ and $A_r = 0.20 A_o$. — Courtesy of Wolverine Tube.

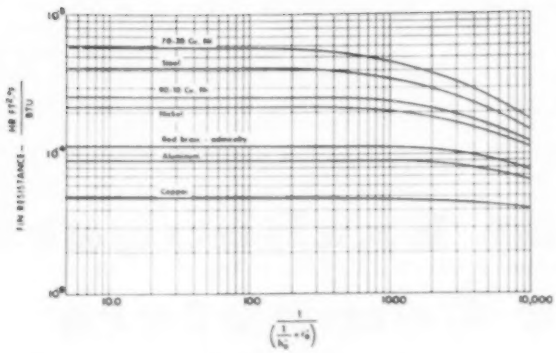

FIG. 5. Fin resistance of 19-fin-per-in. low-finned tubes.

outside coefficient and fouling (from Table 3) the expressions are evaluated as:

$$m = H\sqrt{\frac{2}{\left(\frac{1}{h'_o} + r'_o\right)K_m Y}} =$$

$$\frac{0.048}{12}\sqrt{\frac{2}{\left(\frac{1}{200} + 0.001\right)(65)\left(\frac{0.015}{12}\right)}} = 0.256$$

and

$$\sqrt{\frac{D_o}{D_r}} = \sqrt{\frac{0.737}{0.640}} = 1.072$$

Substituting in Equation 4,

$$\Phi = \frac{1}{1 + \frac{(0.256)^2}{3}(1.072)} = 0.975$$

This value could also have been obtained by use of Fig. 3. The equivalent outside area is calculated using Equation 13:

$$A_{eq} = A_r + \Phi_f A_f = 0.088 + (0.975)\ (0.35)$$

therefore

$$A_{eq} = 0.429 \text{ sq ft/ft}$$

This value could also have been obtained by use of Fig. 4. Substituting A_{eq}, A_o, and h'_o into Equation 15 gives:

$$h_o = 200\left(\frac{0.429}{0.438}\right) = 196$$

Substituting the outside fouling factor, A_{eq}, and A_o into Equation 16 gives:

$$r_o = .001\,\frac{0.438}{0.429} = .00102$$

The tube wall resistance is given by:

$$r_w\left(\frac{A_o}{A_m}\right) = \frac{X A_o}{K A_m} = \frac{(0.050)\ (0.438)}{(12)\ \ (65)\ (0.153)} = .000184$$

The overall coefficient, U_o, is obtained by using Equation 2,

$$U_o = \frac{1}{\frac{1}{196} + 0.00102 + 0.000184 + (0.001)\,(3.39) + \frac{3.39}{1000}}$$

$$= \frac{1}{0.0131} = 76.4 \text{ Btu/hr — °F-sq ft (outside surface)}$$

B. By The Fin Resistance Method

The overall coefficient is computed using Equation 20. The fin resistance is given in Table 2 and in Fig. 5. For the value of:

$$\left[\frac{1}{\frac{1}{h'_o} + r'_o}\right] = \frac{1}{\frac{1}{200} + 0.001} = 166.7$$

the fin resistance from Table 2 is:

$$r_f = 0.000112$$

Substituting into Equation 20 gives:

$$\frac{1}{U_o} =$$

$$\frac{1}{200} + 0.001 + 0.000112 + 0.000184 + 0.001\,(3.39) + \frac{3.39}{1000}$$

$$= 0.0131$$

therefore

$$U_o = \frac{1}{0.0131} = 76.4 \text{ Btu/hr} - °F - \text{sq ft (outside surface)}$$

Discussion

It is a matter of personal choice as to which method is to be preferred. It is apparent that the corrections for fin efficiency are very slight in the above example. With fin efficiencies of 97 percent or higher the error introduced in assuming 100 percent efficiency will give satisfactory designs for most design purposes. The alternate methods give identical results and indicate how fin efficiency can be used in designing finned tube heat exchangers.

Acknowledgment

Permission by Wolverine Tube Division of Calumet and Hecla, Inc. to publish this paper is appreciated.

References

1. Donohue, D. A., *Pet. Process.*, Vol. 11, No. 3, pp. 101-132, 1956.
2. "Standards of the Tubular Exchanger Manufacturers Association," 3rd Ed., TEMA, New York, 1952.
3. Katz, D. L., Knudsen, J. G., Balekjian, G., and Grover, S. S., *Pet. Ref.*, Vol. 33, No. 8, pp. 123-125, 1954.
4. Armstrong, R. M., *Trans. ASME*, 67, pp. 675-681, 1945.
5. Ames, G. W., and Newell, R. G., *Chem. in Canada*, January, 1954.
6. Kays, W. M., and London, A. L., *Trans. ASME*, 72, pp. 1075-1097, 1950.
7. Katz, D. L., Young, E. H., Williams, R. B., and Balekjian, G., *Pet. Ref.*, Vol. 33, No. 9, pp. 303-306, 1954.
8. Beatty, K. O., Jr., and Katz, D. L., *Chem. Eng. Prog.*, 44, No. 1, pp. 55-70, 1948.
9. Myers, J. E., and Katz, D. L., *Chem. Eng. Prog.* Symposium Series No. 5, Heat Transfer, Vol. 49, pp. 107-114, 1953.
10. Williams, R. B., and Katz, D. L., *Trans. ASME*, 74, pp. 1307-1320, 1952.
11. Jameson, S. L., *Trans. ASME*, 67, pp. 633-642, 1945.
12. London, A. L., Kays, W. M., and Johnson, D. W., *Trans. ASME*, 74, pp. 1167-1178, 1952.
13. Schmidt, T. E., Institute of Mechanical Engineering and ASME, Proc. of the General Discussion on Heat Transfer, Section II, London, pp. 186-188, 1951.
14. Katz, D. L., and Geist, J. M., *Trans. ASME*, 70, pp. 907-914, 1948.
15. Zieman, W. E., and Katz, D. L., *Pet. Ref.* Vol. 26, No. 8, pp. 78-82, 1947.
16. Katz, D. L., Young, E. H., and Balekjian, G., *Pet. Ref.* 33, No. 11, pp. 175-178, 1954.
17. Gardner, K. A., *Trans. ASME*, 67, pp. 621-631, 1945.
18. Dusinberre, G. M., *Mech. Eng.*, Vol. 78, No. 6, p. 570, 1956.
19. Mack, D. E., and Pitcher, A. E., *Heating and Ventilating*, pp. 75-78, July, 1950.
20. Skiba, E. J., *Chem. Eng.*, Vol. 61, No. 12, pp. 182-186, 1954.
21. Carrier, W. H., and Anderson, S. W., *Heating, Piping, and Air Conditioning*, pp. 304-318, May, 1944.

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Calculation problems in heat exchangers, flanges, piping system stress analyses by machines has reached production-line stage.

Design of Heat Exchangers On Automatic Computers

A. M. Peiser, M. W. Kellogg Company

THE M. W. Kellogg Company is presently engaged in a program of adapting standard engineering design calculations to automatic computing machinery. All current process and equipment design practices are to be reviewed under this program so that the eventual scope of the computer operation may be assessed. The aim of the program is to extend the use of the computer as a design production line tool as far as is technically feasible and economically justifiable.

In order that the computer be used efficiently in work of this sort, two conditions should be met. First, the burden of assembling the information for a given problem should be placed upon the computer so as to reduce, as much as possible, the "set-up" time required for each individual design. This reduction in "set-up" time is achieved by building into the computer program all of the technical data that are required in the design, so that the engineer need specify only the most essential information related to the problem. The time that would normally be spent in collecting technical data is eliminated.

Second, the computer should carry out the calculations in an automatic fashion, so that the operation can be entrusted to low-level personnel. This has the double advantage of permitting greater flexibility in computer scheduling and, of greater importance, of freeing trained personnel for higher level technical activities. The problem of achieving automatic computer operation represents the major difficulty in adapting the computer to the design production line. Typical design problems place only a modest calculating burden upon the computer. However, the calculations are normally interspersed with decision-making steps ranging from trivial decisions to those that require the utmost of engineering skill and judgment. It is the extent to which the capacity to make these decisions is built into the computer program that determines the automatic nature of the design. While it is undoubtedly true that many design problems are not amenable to treatment in a completely automatic fashion, it is anticipated .hat a sizable quantity of present work can be handled conveniently and efficiently in this manner.

Among the problems which have already reached the production-line stage are the analysis of stresses in piping systems, the design and rating of flanges, and the design of liquid-liquid heat exchangers.

The limitations of present computing facilities (the card programmed calculator) have served to limit the applications to liquid phase, turbulent flow fluids in both the tube and shell sides. Within this area, however, a wide variety of designs has been carried out, encompassing any combination of hydrocarbons, water, or water solutions as the heat exchanging media.

This company has on order, for delivery in the near future a magnetic drum type calculator. In anticipation of this unit, the heat exchanger program has been expanded to include all combinations of single-phase flow, in either the viscous or the turbulent region. Eventually, the program will be extended to include two-phase flow as well.

The advantages expected from computer operation have already been realized to a limited extent in the case of heat exchangers. The use of the computer to date has resulted in the following significant advantages:

(1) Information — The capacity to examine various alternatives in a given design has been greatly increased. Thus, for a given design cost, it is possible to obtain more information more quickly than has previously been possible.

(2) Costs — Experience to date indicates that one computer hour on the CPC is equivalent to about ten man hours. This amounts to a savings of approximately a factor of three in the cost of thermal rating. The comparison will be even more favorable with the arrival of the Datatron.

(3) Schedules — use of the computer has enabled the design engineers to absorb peak work loads which would have required extensive overtime in order to meet required schedules.

ONE COMPUTER HOUR EQUALS ten man-hours on Card-Programmed Calculators; a greater saving is obtainable with higher speed memory-type equipment. This article shows in detail just how computers are employed to speed design of heat exchangers in an engineering organization.

Preparation of Design Data

In keeping with the requirement that the burden of assembling technical data be placed upon the computer, all of the technical data required in exchanger rating have been built into the computer program. Thus, the computer is able to calculate such quantities as viscosities, conductivities, specific gravities, friction factors, heat transfer coefficients, etc., at any operating conditions it may encounter during the course of a design. What is involved here is an extensive program of curve fitting so that existing design charts can be represented within the computer by mathematical formulas.

With such information available as part of the computer program, the task of preparing for a given design case is quite simple. In Fig. 1 is shown a sample exchanger data sheet presently in use. The information required by the computer is only such basic process information as the inlet and outlet temperatures, flow rates, heat duty, allowable pressure drops, and the physical characteristics of the exchanging streams, together with fouling factors, tube dimensions, and the allowable stresses of the metals involved. It will be noted that only a simple signal is needed to enable the computer to distinguish between hydrocarbons, water, or water solutions; the technical data for all of these fluids are built into the program, and the computer decides which to use on the basis of this signal.

The calculation is essentially an iterative one, and is begun with a suitable estimate of the total surface requirements. To this end, as in hand calculations, the engineer is required to supply the computer with a trial value of the overall heat transfer rate. This assumed rate is given on the data sheet along with the other data for the problem, as indicated in Fig. 1.

In many cases, circumstances external to the exchanger may force certain limiting conditions upon the design. Thus, nozzle size, number of passes, minimum surface, or other quantities may be specified in advance. Provision is made on the data sheet for the engineer to indicate such restrictions. The operator handles these special conditions in a routine manner, incorporating them in the computer program as needed.

The Calculation Procedure

An outline of the order in which the calculation is carried out is given in Fig. 2. Starting with the preassigned estimate of the overall heat transfer rate, the computer carries out a complete design, performing the following steps:

(1) Determination of the number of shells in a series.

(2) Calculation of the log mean temperature difference.

(3) Determination of shell and channel nozzle sizes.

(4) Calculation of shell size and number of passes.

(5) The complete tube sheet layout.

(6) The spacing and cut of the baffles.

(7) The calculation of heat transfer rates and pressure drops on both the tube and shell sides.

Many of the crucial steps in the design, such as the selection of the shell size, the number of passes, the tube sheet layout, the baffle arrangement, etc., are not amenable to solution by simple mathematical formulas or by the direct calculation. To enable the computer to make the decisions neces-

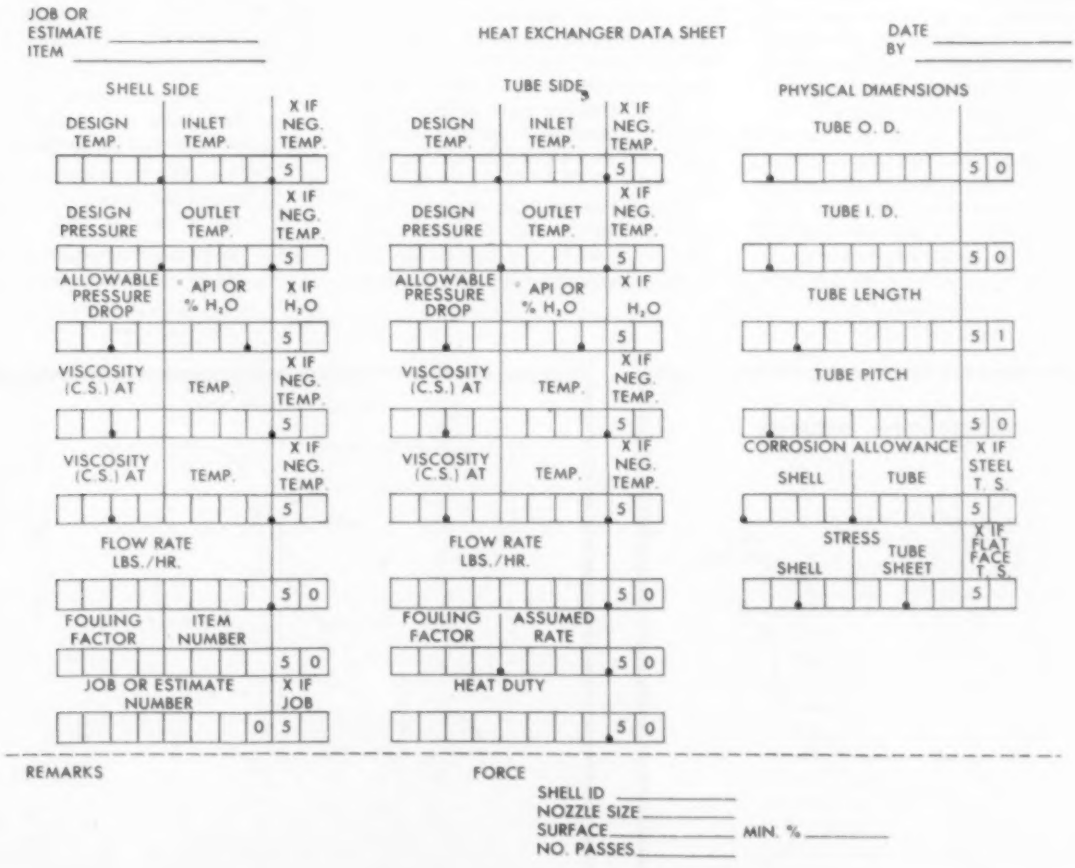


FIG. 1 Typical data sheet for computer calculation use.

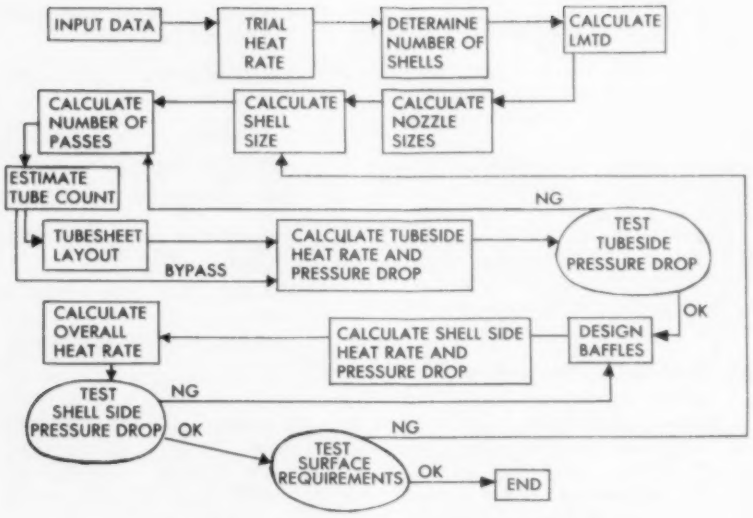


FIG. 2. A plan for heat exchanger design calculations.

sary to carry out these steps, the requirements of each situation must be formulated in mathematical terms, usually by means of a system of inequalities, and convergent methods must be devised to obtain appropriate solutions.

In some cases, where such a formulation would be of very great complexity, the difficulty is overcome by a simple step-by-step procedure. An example of this is the selection of a new shell size at the end of a given trial rating. If, after one trial, the exchanger is under (or over) surfaced, the trial shell size is simply increased (or decreased) by one standard size and the rating is repeated. It will be noted that the engineering judgment normally applied at this point is merely a device for reducing the number of trials. The inability of the computer to exercise this judgment is compensated for here by the speed with which it carries out successive trials.

The number of trials required, and hence the rapidity with which the computer arrives at a final design, is strongly dependent upon the assumed trial heat transfer rate. In some cases, with a good guess, a single run through the computer is sufficient. In cases where the guess is a bad one, many runs may be required. The situation is analogous to "hand calculations in which, depending upon the individual exchanger, a highly variable number of trials is needed to satisfy the surface and pressure drop requirements.

Tubesheet Layout

Perhaps the most formidable problem that arises in the design is the tubesheet layout. Because of the multiplicity of possible layouts, due to variations in shell size, tube size and pitch, nozzle sizes, and number of passes, existing information on tube count versus shell size is fragmentary. Thus, it was not possible to build a complete table of layouts into the computer program. Since the program is required to handle exchangers of any size or condition, it is necessary for the computer to be able to determine its own tube count for any shell that it might arrive at during the design.

The problem may be stated as follows: Given the shell size, the number of passes, the nozzle sizes, the tube size, the tube pitch, and the tube spacing at partitions, it is required to arrange tubes in rows in such a way that:

(1) No tube encroaches upon the shell, upon the partitions, or upon the nozzle openings,

(2) The distribution of tubes among the passes is as nearly even as possible, and

(3) The maximum number of tubes is used.

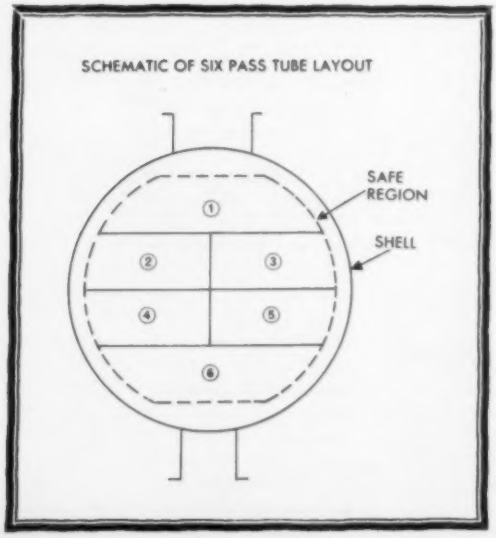


FIG. 3. Schematic diagram for six-pass tube layout.

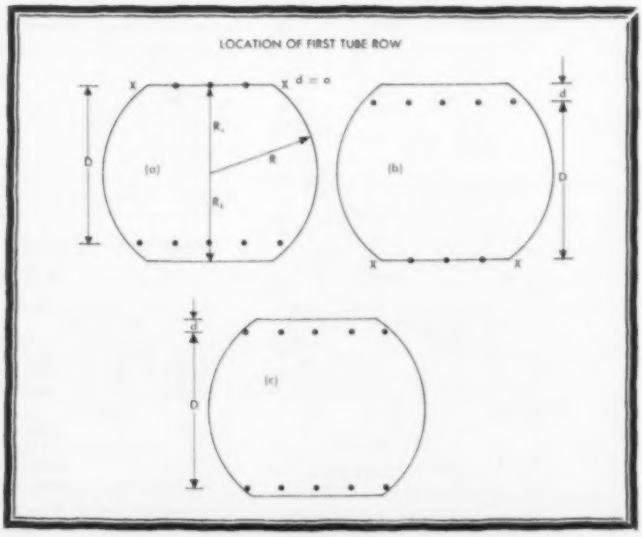


FIG. 4 Layout for determining location of first tube row.

The physical characteristics of the shell and the nozzles define a "safe region" within which tube centers may be placed without encroaching upon the shell or the nozzle openings. Such a region is indicated in Fig. 3. Tubes must be placed within this region in successive rows, with due regard for the spacing required by the partitions. The partitions are normally set in an "H-type" arrangement as determined by the number of passes. A six-pass arrangement is shown schematically in Fig. 3.

The layout on the computer proceeds in what might be regarded as the mathematical counterpart of the procedure followed by a layout draftsman. The computer first makes an estimate of the total tube count, and hence of the average number of tubes per pass. It then starts to count tubes in rows beginning near the inlet nozzle. Additional rows are added until the total tube count is as close as possible to the estimated number per pass. This concludes the first pass.

If there are more than two passes, the computer then begins the "H-type" arrangement in which pairs of passes are placed symmetrically about the center-line. The tube arrangement is as above, except that the center-line of tubes is removed to provide space for the partitions. Again, tubes rows are added until the tube count is as close as possible to the estimated number of tubes per pass.

The process continues until the final pass is reached. In this pass, tube rows are added until the outer limit of tube rows is reached.

The layout procedure has been programmed as an integral part of the design calculation. The computer counts tubes, decides when the end of a pass is reached, switches to the H-type arrangement if needed, switches back to the straight type for the final pass, keeps track of the tubes needed for the determination of the free diameter, and ends the layout at the final tube row. Some of the problems arising in the layout are discussed in the Appendix.

A summary of some of the layouts carried out on the computer is given in Table I. In most cases, computer layouts compare favorably with hand layouts, although the distribution of tubes among the passes has tended to be more uneven. In the subsequent rating, however, only the total tube count is important and here the computer has generally tended to agree with hand layouts. In some cases, an experienced layout man can improve somewhat upon the machine solution by employing various degrees of judgment not built into the present program. It is anticipated that, with the greater flexibility available on a magnetic-drum type computer, and with the experience gained to date, modifications can be made in the program to permit the computer to do as well as the draftsman in virtually all cases.

TABLE I — SUMMARY OF COMPUTER TUBE SHEET LAYOUTS

Shell ID	Nozzle Size	No. of Passes	Tube OD	Machine Layout	Total Tubes: Machine	Hand Layout
12	4	2	¾	39 / 30	69	69
12	4	4	¾	21 / 16 16 / 10	63	63
15¼	4	4	¾	40 / 32 32 / 32	136	138
19¼	6	2	1	66 / 66	132	132
19¼	6	4	1	27 / 30 30 / 40	127	127
18	8	6	¾	24 / 27 27 / 26 26 / 9	139	143
42	10	8	¾	152 / 140 140 / 133 133 / 138 138 / 138	1112	1112

In order to start the layout, as indicated above, the computer must first estimate the total tube count. Inasmuch as it is only the tube count that is required in the subsequent rating, it is evident that there would be considerable advantage in estimating the count fairly accurately. It would then be necessary to make only one layout, after the design has been completed, and the proper shell size and number of passes determined.

We have developed a suitable approximation for the tube count. It is obtained simply by a careful determination of the area available for placing tubes. The tube count is estimated in the form:

$$\frac{(\text{area of safe region}) - (\text{area of partitions})}{(\text{tube pitch})^2}$$

In Table II is given a comparison of estimated tube counts and the actual tube counts obtained from detailed layout calculations. The errors in the estimated count are well within the accuracy required in design.

As a result, in the actual calculation on the computer, the layout is completely by-passed during the various trials. The by-pass circuit is indicated in Fig. 2. In practice, the layout is rarely calculated, even on the final run. Aside from a few borderline cases in which the precise tube count is critical, the estimated tube count has been found to be entirely satisfactory.

Production Experience

Most exchangers are processed by the computer quite unspectacularly, in the routine fashion of production work. Occasionally, however, a case arises in which it is reasonable to believe that the computer has yielded a better design than would have been obtained by hand. This is in no sense a reflection upon the heat exchanger engineer. Rather, it is the direct result of the ability of the computer to perform a large volume of calculations in a short time. It is comparatively easy, in a doubtful case, to try a smaller shell size, for example. Little is lost if it does not work, and much is gained if it does. The demands of production schedules rarely permit this type of experimentation in hand calculations.

The computer has been used very effectively in water conservation studies related to the design of coolers. The problem is that of striking an economic balance between the quantity of water and the amount of surface required to meet a given heat duty. It is not uncommon for several cases of the same cooler to be submitted to the computer, each with a different assigned outlet water temperature (or water flow rate). From the resulting

designs, it is relatively easy for the heat exchanger engineer to select the one most suited for the particular application under consideration.

Appendix

Some of the problems that arise in tubesheet layouts on the computer are:

(1) **First tube row:** The computer is faced in on the problem of deciding the location of the tube rows. It is a question of whether to take the first row as near the inlet nozzle as possible (Fig. 4 (a));or the last row as near the outlet nozzle as possible (Fig. 4 (b)); or to use some intermediate location (Fig. 4 (c)). In general, the question is resolved as follows (see Nomenclature): The distance between extreme rows must satisfy the inequality

$$D = (n-1)p + \frac{m}{2}(q-p) \leqslant R_1 + R_2$$

so that

$$n \leqslant \frac{R_1 + R_2 = \frac{m}{2}(q-p)}{p} + 1.$$

Using the "greatest integer" notation ([x] = the greatest integer in x), we have

$$n = \left[\frac{R_1 + R_2 - \frac{m}{2}(q-p)}{p} + 1 \right].$$

If d denotes the distance the first tube row is moved **away** from the inlet nozzle side, then the half-length of the last tube row is given by:

$$L^2 = R^2 - (D + d - R_1)^2$$

and the number of tubes in the last row by:

$$t_n = 2\,[L/p] + 1.$$

We choose "d" so that there is no wasted length in the last row, that is, so that

$$L = p\,\frac{t_n - 1}{2}.$$

If we add the restriction that the last row must not encroach upon the outlet nozzle, we have:

$$d = \min \begin{Bmatrix} R_1 - D + \sqrt{R^2 - L^2} \\ R_1 + R_2 - D \end{Bmatrix}$$

(2) **Estimated tube count:** Since each tube requires an area equal to p^2 within the safe region, the tube count can be estimated from the total area available for tubes. The area of the safe region is:

$$A = R^2 \left\{ \pi - \arctan\left(\frac{\sqrt{R^2 - R_1^2}}{R_1}\right) - \arctan\left(\frac{\sqrt{R^2 - R_2^2}}{R_2}\right) + R_1\sqrt{R^2 - R_1^2} + R_2\sqrt{R^2 - R_2^2} \right\}$$

From this must be subtracted the area lost because of the partitions. This is estimated as

$$(q-p)mR$$

and we obtain the estimated tube count from:

$$N_{est} = \left[\frac{A - (q-p)mR}{p^2} \right]$$

(3) **Location of partitions:** The computer attempts to place in each pass a number of tubes as close to (N_{est}/m) as is possible. Suppose that, after j rows, the total count in a given pass satisfies the inequality

$$T_j = \sum_{i=1}^{j} t_i \geqslant \frac{N_{est}}{m}.$$

Then, if

$$T_j - \frac{1}{2}\,t_j \leqslant \frac{N_{est}}{m}$$

the j-th row is the final row of the pass. Otherwise, the $(j-1)^{st}$ row is the final row.

Nomenclature

D = distance between first and last tube rows

d = distance first row is moved from extreme location

m = number of passes

n = number of tube rows

p = tube pitch

q = tube pitch at partitions

R = radius of safe circle

R_1, R_2 = maximum displacement of extreme tube rows at inlet and outlet side, respectively

t_n = number of tubes in row n

T = number of tubes in a pass

TABLE II. Comparison of Estimated and Actual Tube Counts

Shell ID	Estimated Count	Actual Count	Per cent Error
12	70	69	1.5
12	66	63	4.8
15¼	138	136	1.5
19¼	131	132	−0.8
19¼	126	127	−0.8
27	454	460	−1.3
35	798	806	−1.0
42	1128	1112	1.5

* * *

"This'll get a load off my mind."

'Process Type' Instruments

Installed on New Refinery Boiler

Conventional refinery instruments ease maintenance problems, permit wide flexibility at Creole's Amuay Bay refinery

H. G. Morgan *Utilities Superintendent*
Creole Petroleum Corporation
Amuay Bay, Venezuela

RECENT expansion of petroleum refining facilities at the Amuay Bay refinery, of the Creole Petroleum Corporation in Venezuela, resulted in a substantial increase in steam demand. In anticipation of this increased demand, a new generator, rated at 200,000 lb per hr, 615 psig, 760 F, was installed in 1954.

Because refinery power plants, in which all of the required steam and electricity are generated, must be integrated with and subordinate to the needs of the various process units, a somewhat different control problem was faced compared to that of a large central station installation.

In this particular case two 180,000 lb per hr steam generators were already supplying processing steam at Amuay Bay and three 9375 KVA turbine driven electrical generating units were also operating before the new boiler was installed. Both of the older boilers were equipped with conventional combustion controls, which left much to be desired from the standpoint of the refinery power plant operator.

In addition to operating convenience, two other prime requirements governed the choice of the new control system and equipment.

1. Careful consideration should be given to the related action of the master pressure controller and the fuel flow-air flow controls in handling sudden and severe load changes.
2. Provision should be made to compensate for the immediate "swell" effect felt by the level controller under conditions of rapid load change. The level control system should ignore transient indications and maintain dynamic control of the rate of boiler water feed in direct ratio to steam consumption. At the same time, any true increase or decrease in drum level must be automatically corrected to insure safe operation.

Instrumentation Requirements

With regard to instrument application, the boiler was treated the same as any other process unit that requires automatic control to obtain optimum results from both operators and equipment.

Accordingly, control system design took the following direction:

1. The measuring and controlling devices are similar to the "process type" instruments used throughout the main refinery. In this way, the refinery instrument department, already thoroughly familiar with that type of equipment, has no difficulty maintaining the boiler house equipment. Spare instrument parts and supplies used in the refinery also serve to maintain the new equipment.
2. The system is flexible enough to maintain stable control at all times under different load conditions and with widely different types of fuel.
3. The boilers are operated from a central control panel by a minimum number of men. Graphic illustration of the boiler and control system is used to facilitate operator training.
4. All important variables are recorded so that the station superintendent can easily review past operations. Necessary records of steam produced, water consumed, and other essential data are available to the accounting departments.

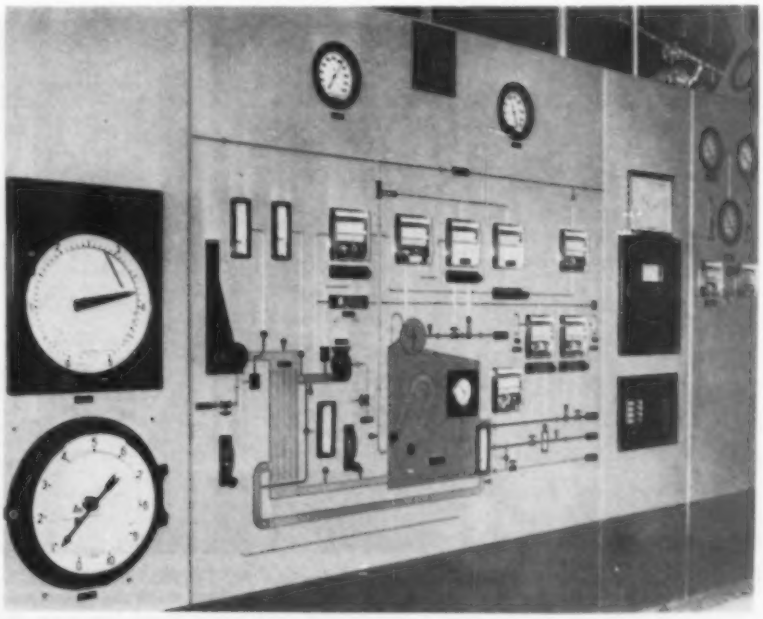


FIG. 1. A graphic control panel is the focal point of the boiler control system.

FIG. 2. This base-loading, load-balancing station permits the engineer to remove a boiler from the master controller. Output of the base-loaded boiler is changed by manual adjustment of the control index of its boiler stream flow controller.

The generally accepted principles of combustion control were followed, but because the instrumentation was designed around the type of equipment more commonly found in refining and chemical processes, some differences were inevitable. All of the various recording and indicating control stations are standard Foxboro Model 53 Consotrol instruments and the many standard auxiliary devices — ratio, pneumaticset-ratio, pneumaticset—were invaluable in establishing a completely interconnected control system.

Control Panel

The focal point of the control system for the boiler is a Foxboro graphic control panel on the operating floor, shown in Fig. 1. As a memory aid to the operating engineer, the points of measurement, positions of valves and damper operators, and instrument interconnections are shown in a simplified flow diagram of the unit.

To use the centralized panel to best advantage, the important measurements are transmitted pneumatically. Temperatures are measured electronically from thermocouples. Air for the instruments is taken from the main refinery air header through a reducing station and a complete drying and filtering unit. A separate stand-by compressor automatically cuts-in if there is a failure. As further protection, an emergency air lock system is arranged so that if there is a complete air failure every valve and cylinder operator will be held in its last operating position until the lockup is released by the station engineer.

Master Pressure Control

The combustion control system is directed by a master pressure controller connected to the main steam header. Operating from a supersensitive measuring element this instrument responds to minute changes in header pressure and adjusts the combustion air and fuel systems to maintain the pressure at the desired setting regardless of load changes. The engineer in the boiler house can manually change the setting of the master pressure controller to raise or lower the refinery header pressure and the boilers will automatically adjust for the change in load.

A base-loading load-balancing station shown in Fig. 2 permits the engineer to remove a boiler from the master controller for base load operation. The output of the base loaded boiler is changed by manually adjusting the control index of its boiler steam flow controller while the remainder of the control system remains on automatic operation.

The load balancing regulators make it possible for the engineer to modify the master controller output to adjust relative loading of individual boilers.

Combustion Air Flow Control

Flow of combustion air is measured and transmitted to an air flow controller, the output of which operates the cylinder positioner for the forced draft fan outlet damper. Air flow is adjusted in accordance with the demand of the master pressure controller on load balancing, and the boiler steam flow controller on base load. In either case, increased demand results in increased combustion air flow.

Fuel Flow Control

The flow control system for fuel gas and fuel oil automatically proportions the flow of these two fuels according to their availability.

In operation, the output signal from the air flow transmitter sets the control indexes for the fuel controllers through ratio relays, guaranteeing air availability for burning the fuel. This arrangement is somewhat different from other combustion control systems, but was considered desirable because of possible lag in obtaining air flow sufficiently fast after an increase in fuel flow. The flow ratio of the two fuels is established by the setting levers on the ratio relays.

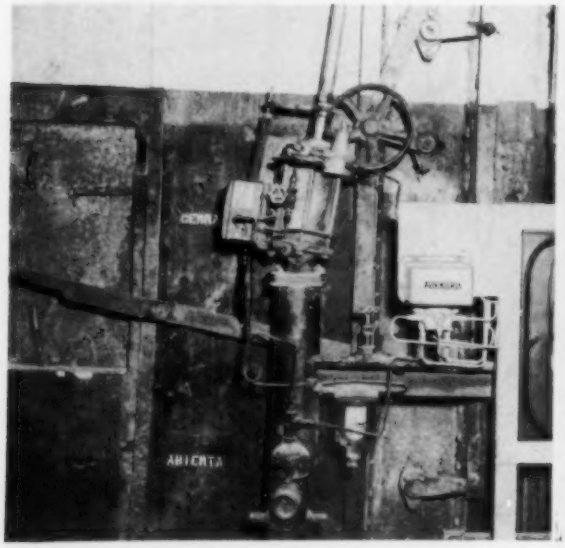


FIG. 3. The cylinder positioner for the induced draft fan inlet damper is pneumatically operated, is controlled by furnace pressure.

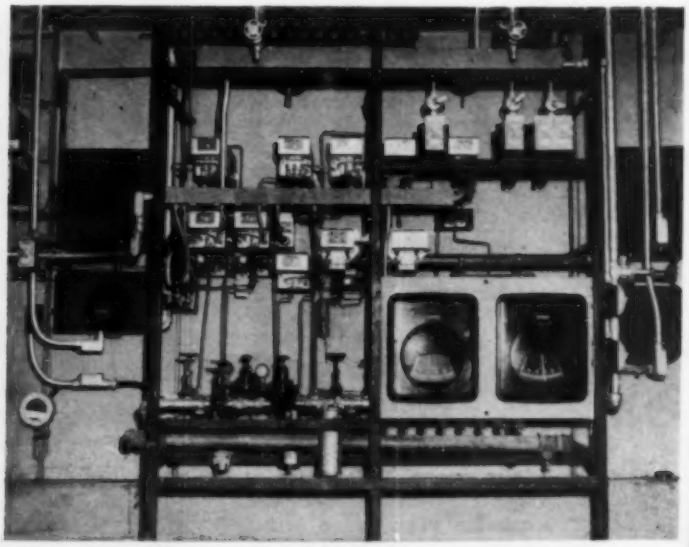


FIG. 4. Behind the control panel. Temperatures are transmitted electronically, other measurements pneumatically. Here can be seen the speed bias relays that are used to control combustion air flow and furnace pressure.

Furnace Pressure Control

Furnace pressure is measured and transmitted to a panel-mounted indicating control station and to a field-mounted controller which pneumatically operates the cylinder positioner for the induced draft fan inlet damper as shown in Fig. 3. Manually setting the control index at the control station sets the control point of the field-mounted controller to establish optimum firebox conditions. Normal setting of the draft controller is minus 0.1 in. of water but it is a simple matter during operation to change the control point setting manually to any required value.

Fan Speed Bias Control

Combustion air flow and furnace pressure are controlled primarily by dampers and secondarily by speed control of the fans. The portions of damper stroke in which speed bias control is desired are established by setting the trip points for the speed bias relays mounted behind the panel as shown in Fig. 4.

Boiler Level Control

Because of the high steaming rate, small steam drum, and low boiler water-holding capacity, it was expected that the "swell" effect would be considerable, making control of level somewhat difficult. The drum level control system consists of three elements: A ratio flow controller for feed water flow and steam flow, with the ratio setting automatically changed by a level controller. On the theory that for every pound of steam produced a pound of water must be added to the boiler, there is a predetermined ratio between feed water flow and steam flow. The level controller on the drum acts in a supervisory capacity and automatically adjusts the ratio between feed water and steam flow to hold the level constant.

As considerable "swell" effect was anticipated in this installation it was necessary to include a special device which introduces an adjustable time delay in the response of the level controller to change in steam flow. The delay allows feed water flow to parallel steam flow during transients thereby minimizing "swell" or "shrinkage." The time delay can be adjusted to match the time constant of the boiler.

Monitoring Instruments

In addition to control instrumentation, indicators and recorders are provided for important variables such as feed-water pressure, feed-water conductivity, flue-gas oxygen content, and selected plant temperatures.

Results of the System

The boiler and its instrument system have been in service approximately two years. In that time, the following conclusions have been established:

1. The graphic flow diagram has definite value during emergencies and in training new operators.
2. The use of "process-type" instruments did not complicate operator training.
3. Instrument maintenance has been greatly simplified through the use of "process-type" instruments.
4. The instrument system has performed much better than the conventional power plant control systems on other boilers in the refinery.
5. Space has been saved.
6. Operators have highly praised the convenience, flexibility, tight control, and ease of handling which this type of system provides.
7. Use of the "process unit" approach to boiler instrument application is valid and sound. ★

About the Author

H. G. Morgan is the utilities superintendent at Creole Petroleum's Amuay Bay refinery.

He's well qualified to write on the subject of instrumentation, having spent some time with an instrument manufacturer as an assistant resident engineer.

He has a bachelor's degree in electrical engineering from Georgia Institute of Technology, granted to him in 1939. During the war years he was general foreman of the electrical and instrument department at Sohio's Lotonia refinery, and then joined the Foxboro Company in 1945. In late 1947, he went south of the border, with Creole.

Prior to taking his present post, he was project superintendent of engineering and construction of new units at Amuay Bay refinery.

New Tray Gasketing Reduces Leakage

Designed specifically to meet installation and service conditions incident to sealing joints between tray sections and around the tray circumference, a new gasketing made of pure asbestos fiber and knitted Monel wire has been developed. Conventional gasketing generally used for such installations is made of asbestos and cotton woven in tape form.

When conventional gasketing was used to seal these joints, in a column at a large East Coast refinery, it was found difficult to keep water-test leakage to the desired minimum, even on new installations made at normal turn arounds. And after a year's run, leakage was often as high as 370 percent above allowable, with serious effects on production and product quality. Examination of trays showed excessive localized leakage at these joints. Conventional gasketing generally had to be replaced. It had not only lost its resiliency, but the cotton had become charred away, leaving open spaces along the joints. General overall leakage through risers and caps, while definitely present, was apparently not so serious a consideration.

Tray No. 28 of a 9-ft ID atmospheric tower in a crude oil pipe still was selected for the first installation of this new tray seal because it had been a particularly troublesome "leaker" with conventional gasketing. Operating temperatures of 200 F with highly corrosive conditions literally "burned out" the cotton, resulting in excessive localized leakage at the end of the run.

When the new tray seal was first installed, leakage tests show 6 percent under allowable, with no localized leakage. At the end of a year's run, total tray leakage had risen to only 67 percent above allowable, compared to the 370 percent previously experienced. Moreover, examination of the tray during tests showed that only 20 to 25 percent of this leakage was traceable to the gasketed joints. The tray seal showed no charring, was still resilient and was not replaced. Tightening of a few of the tray section bolts was the only attention required.

As a result of this experience over a full year's run under normal operating conditions, tray seal was installed on all 29 trays within this tower. In addition this new gasketing also was installed on Tray No. 8 in the 18 ft 6 in. ID vacuum tower at the same unit. Here temperatures are in the range of 730 to 750 F. Tests at the start of the run showed total tray leakage 19 percent below allowable. Thus far it has only climbed to approximately 4 percent above allowable. Tests to determine how much of this is localized and how much is overall cannot be made until the next scheduled turn-around.

Logan C. Waterman
Petreco Division
and J. R. Moechel
Tretolite Division,
Petrolite Corporation.

This month's feature report —

Crude Oil Desalting

A MUST FOR THE MODERN REFINERY

Salt removal may boost throughput by one-third; operating costs are almost negligible

A MAJOR refinery problem has been the disabling of distillation equipment by salt water. Even the most modern refinery is subject to severe damage if reliable desalting and dehydration equipment does not function continuously. Consequently, the separation of crude oil, salt and water has been a major, though sometimes poorly recognized, problem of the industry. In early days, vast quantities of crude have been wasted or destroyed by burning because of brine content that made the crude unmarketable in the field or unusable at the refinery.

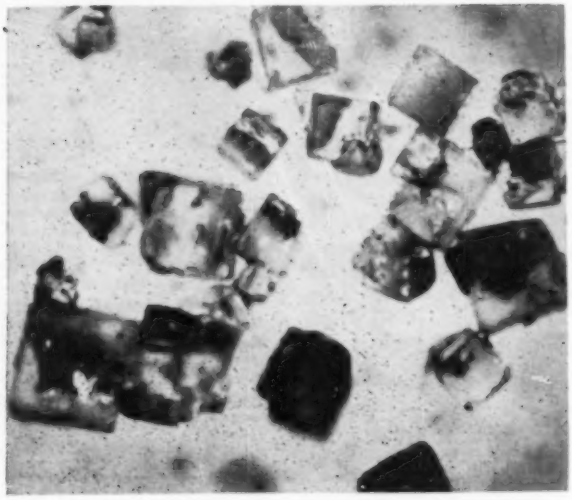
Brines in Crude Oil

Brines reside in crude oil principally because salt water generally underlies the crude oil in the geological formation from which it is produced. With careful production methods it is possible to produce wells initially with no salt water. However, as the producing life of a field is extended, increasing proportions of salt water are produced with the oil. Salt water encroachment normally starts at the edge of the fields and progresses until the production is predominantly water rather than oil. The oil field waters which are produced with crude oils vary widely in composition and the amount of salts which they carry in solution, but their concentration is generally greater than that of sea water, and they are therefore termed "brines."

Emulsification of the water and oil issuing from wells occurs in the formations themselves, and in mechanical equipment such as pumps, chokes, gas separators and piping. These emulsions may comprise varying proportions of oil and water, from 0 percent to 100 percent, but pipelines will not purchase the oil until its water content is reduced to the 0.5 percent to 2 percent range, varying with the specifications prevalent for the geographical area and the purchaser. These particular values for the maximum water contents are dictated, not by the amounts which the refinery would prefer to have, which is no water at all, but rather by the difficulties of reducing commercially the water contents in crude oils to lower values by even the best dehydration methods.

The water exists predominantly in the form of dispersed particles (water-in-oil type of emulsion) which will vary in size from large drops down to small ones of about 1 micron (.00004 in.) diam. Character of the water and of the oil (gravity, surface tension,

FIG. 1. Typical forms of salt crystals in crude oil.



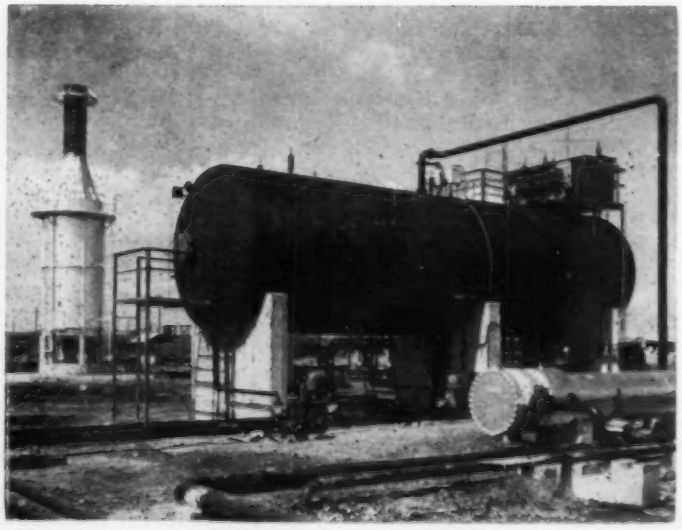


FIG. 2. Electrical dehydrator at Lagunillas, Venezuela, handling 8500 bbl per day of 15 API gravity crude.

chemical constituents, etc.) and production methods will determine the size distribution and stability of emulsion particles. These drops are stabilized by adsorbed films of naturally occurring emulsifying agents in the oil, which are surface-active materials such as asphalts, resins, waxes, solids and organic acidity. Thus, the amount of salt which will be carried by the crude oil as it arrives at the refinery will vary not only according to the amount of water left in it, but will also depend on the salt concentration of this residual brine.

Another source of brine contamination resides in tankers. Ballast (sea water) becomes mixed with crude oil while the vessels are at sea and during the discharge of the oil from the tankers to shore installations.

Analysis of Brines

Normally, at refineries, analysis of the amount of salt in crude oil is made by titration for chlorides, though sulfates and carbonates are generally also present and in some cases sulfates are predominant (Wyoming, Posa Rica, etc.). The geologic formations (water-bearing sands, gypsum, limestone, dolomite, etc.) from which the oil comes influence the composition and concentration of brines, and concentration of salts in the brine will vary widely from field to field. For each 0.1 vol percent of water the salt content in the crude oil may vary from 2 ptb* to 100 ptb. Though the pattern is random, an average figure of 20 ptb for each 0.1 vol percent of water is common. Of the chlorides, the distribution of salts may be about 75 percent sodium, 15 percent magnesium, and 10 percent calcium.

The approximate average of water contents of crude oils received at refineries during recent years is 0.3 vol percent. The average salt content reported, as sodium chloride, is approximately 60 ptb. The range of daily average salt content in the raw crude charge is from 5 ptb to 200 ptb; spot samples may show much higher values. The individual particles of brine in the crude received at refineries are usually 1 micron or less in diameter and are the most refractory portion.

Crystalline salt will occur only occasionally in crude oil, as when considerable gas is produced with it and evaporation due to gas "stripping" of water occurs. It is more commonly found as part of the refinery charge when topped or reduced crude is mixed into it, and in such cases its presence requires severe desalting procedures. Fig. 1 shows how crystalline salt in a crude oil appears under the microscope.

*ptb = pounds per thousand barrels of crude. 1 ptb = 2.85 parts per million, approx.

Dehydration of Crude Oil

Dehydration of the crude oil emulsion is accomplished by gravity separation or settling of the water particles, which, under proper viscosity conditions that may be provided by heat, proceeds readily with the larger particles. However, the smaller particles must be coalesced to particles large enough to settle into a continuous water layer within a practical period.

To permit coalescence of these smaller particles upon contact, the stabilizing effect of the film, adsorbed at the oil-water interface, must be counteracted by demulsifying chemicals of higher surface activity. These chemicals are chosen empirically from a multitude of available compounds. They are more or less specific for the wide variety of petroleum emulsions, which suggests that the mechanism of the emulsion-resolving process is too complex for explanation by any simple theory. They are added generally in ratios of from 1 part in 10,000 to 1 part in 100,000 of treating chemical to oil; in some cases, only a few parts per million will suffice.

Electrical resolution of oil field emulsions is accomplished by subjecting them to electrical fields of high gradient, e.g., several thousand volts per inch. Under the influence of the electrical field, water droplets become mutually attractive due to induced electrical charges on the drops. The effect of these charges, and the resultant forcible collision of drops, overcomes the stabilizing films and a rapid separation of the oil and water phases follows. As coalescence progresses, the distance between particles increases

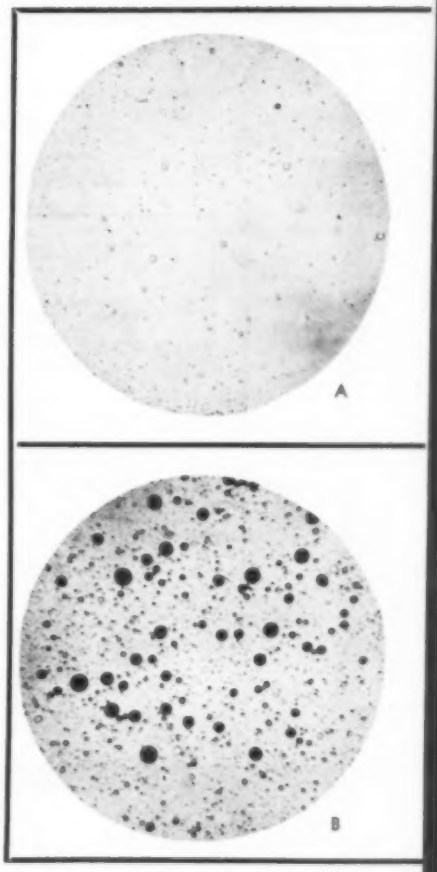
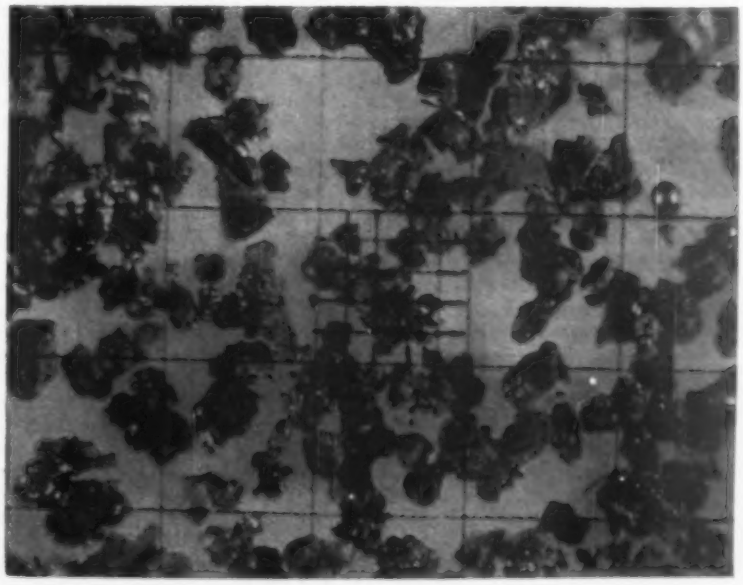


FIG. 3. Photomicrographs illustrating emulsification in desalting: (A) oil to be desalted; (B) the same oil emulsified with 10 percent fresh water.

FIG. 4. Photomicrograph showing solid abrasive materials found in crude oil.



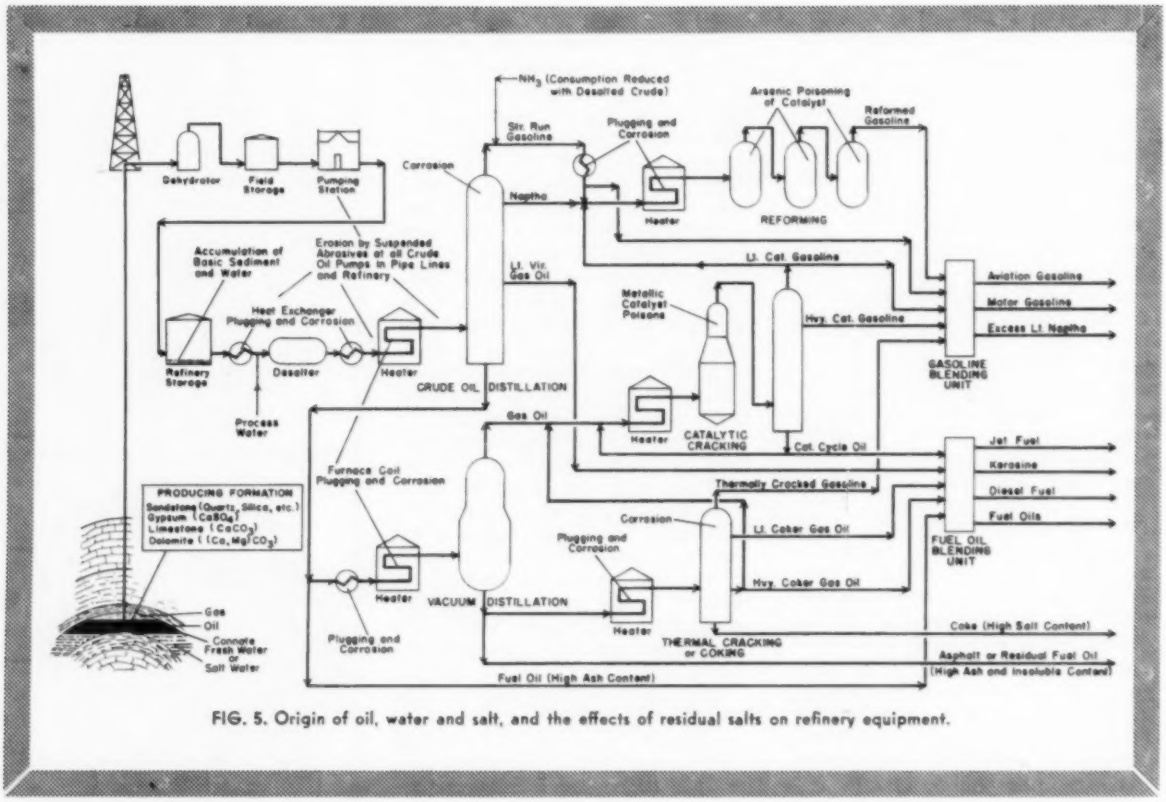


FIG. 5. Origin of oil, water and salt, and the effects of residual salts on refinery equipment.

and the size of remaining drops and the probability of collision diminishes. The practical economic limit of dehydration is reached when a few tenths of one percent of brine remains and this will consist of the smallest and most stable emulsion particles.

Dehydration in most producing fields of the United States is generally accomplished by the addition of chemical demulsifiers at the wells. The oil is warmed in heating tanks and the brine is drained off in settling tanks or "gun barrels" from which it flows into field storage tanks. On the Pacific Coast, in Canada and in South America, electrical, as well as chemical dehydration is used widely. Fig. 2 shows an electrical dehydrator at Lagunillas, Venezuela, which dehydrates 8500 bbl per day of 15 deg API gravity crude. Electrical equipment is particularly advantageous on low gravity crude oils.

In the field gathering systems and in pipeline transportation systems it is not practicable to segregate salty oil from clean production. Therefore, refineries receive mixtures of salt-bearing crude oil, though a portion of it initially might have been clean.

Desalting of Refinery Charging Stocks

In the previous section it was stated that it becomes progressively more difficult to reduce the brine content as its residual quantity diminishes, and that the practical limit is a few tenths of one percent. The problem of reducing the salt content of the crude oil is approached at refineries by way of an ingenious expediency. The amount of emulsion is increased by dispersing intimately about 5 percent of fresh water into the crude and again resolving the combined emulsion by chemical or electrical means. Although the same limitation of particle size and distance of separation prevails on the final cleanup of the last portion of the synthetic emulsion, by better control of the process at refineries the residual portion may be less in percentage and may consist essentially of the added fresh water, relatively free of salt.

Efficient desalting is dependent first on the preparation of a synthetic water-in-oil emulsion, dispersed enough to be effective but susceptible to separation, and second on the resolution of that water-oil mixture into its components of salt-free oil and saline water. When the fresh water is emulsified properly with the salty oil, there is at first very little coalescence between the brine and the fresh water as a result of the mixing procedure. This is shown graphically in Fig. 3 where A is a photomicrograph of a salty oil containing about one percent salt water and B is the same oil into which about ten percent of dyed fresh water has been incorporated.[3] Close scrutiny shows that in the fresh-water mixture there are still visible particles of the original brine emulsion which co-exist with the added fresh water particles. This is characteristic of these systems even when the fresh water is incorporated with fairly intense mixing methods.

Some solid material is often produced with crude oil and some additional solids are picked up during passage of the oil through pipelines. Field dehydration and storage account for the removal of most solids, but significant quantities can reach the refineries. Comprised of silt, silica, iron oxide, iron sulfide and occasional welding splutters, the solids are normally associated with the water particles. Because of this association and the tendency of the solids to become water-wetted by the synthetic emulsion, desalting is quite effective in removal of solids.

In a report of April 17, 1947,[4] prepared for the Joint API-ASME Committee for Volumeter Research, it was stated that "The principal cause of wear on closely fitted moving elements of equipment handling crude oil, neglecting effects of corrosion, is the grinding

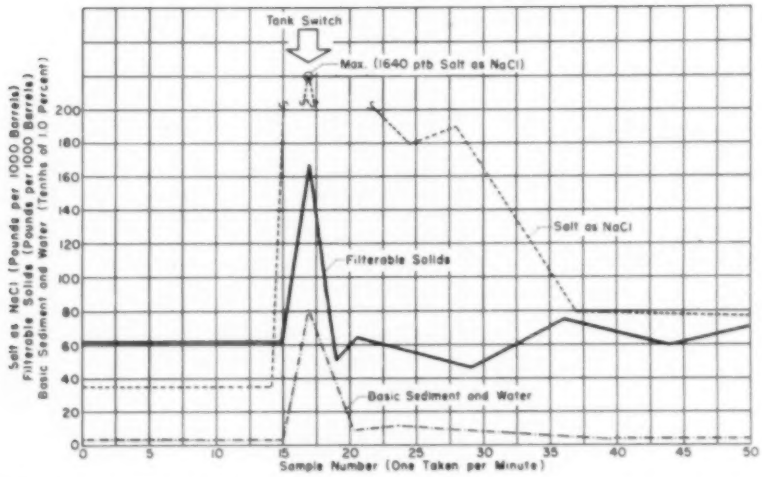

Tank Switch
Max. (1640 ptb Salt as NaCl)
Salt as NaCl
Filterable Solids
Basic Sediment and Water
Salt as NaCl (Pounds per 1000 Barrels)
Filterable Solids (Pounds per 1000 Barrels)
Basic Sediment and Water (Tenths of 1.0 Percent)
Sample Number (One Taken per Minute)

FIG. 6. Variation in bs&w, salt content and solids include charge stream during switching of storage tanks.

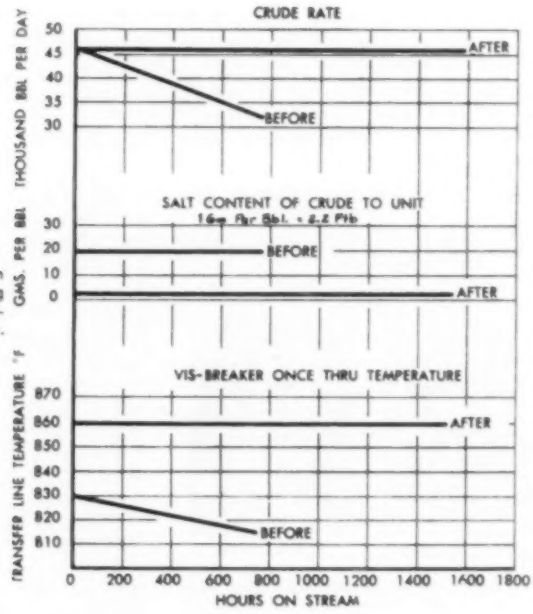


FIG. 7. Typical runs and run conditions on a cracking unit before and after desalting, in a Gulf Coast refinery.

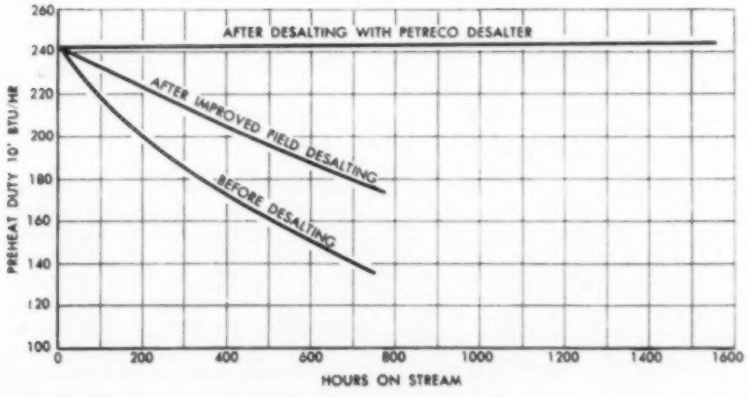


FIG. 8. Loss in preheat duty, at cracking unit, before desalting, after improved dehydration, and after the desalter was installed.

or abrasion resulting from the solid matter that is entrained or suspended in the crude oil." Fig. 4 is one of several excellent photomicrographs included in that report, showing the presence of this objectionable material.

Present-day desalting systems are relied on to remove other deleterious materials from the oil and from the water. For example, by adjustment of the desalting operation, significant quantities of arsenic can be removed from the crude, thereby avoiding its carry-over into catalytic reformers, where it is an objectionable poison to platinum-type catalysts when present in concentrations of about 5 parts per billion or more of reformer charge.

TABLE 1. No. 2 Cracking Unit Run Summaries.

Run no.	Hr on-stream	†Service factor	Cause of shutdown
Before desalting			
41	930	78.8	Salt fouling of the crude preheat exchangers and visbreaker once-through furnace coils.
42	590	88.2	"
42A	425	83.4	"
42B	828	72.7	"
43	842	83.5	"
*43A	615	86.6	"
43B	152	74.5	Ruptured upper roof tube in the visbreaker once-through coils.
43C	786	79.8	Failure of elbow on crude preheat exchanger. Scheduled shutdown two days later for salt removal.
44	1157	72.1	Failure of furnace-oil stripper reflux line.
45	691	83.6	Unit shutdown March 8. Ruptured roof tube in visbreaker once-through coils caused by excessive heating due to salt deposits.
Avg.	702		
After desalting			
45A	2172	89.8	Heavy coke deposits in the high pressure evaporator.
46	720	90.6	Fire in convection section of the visbreaker furnace.
46A	857	92.6	Leak in blow-down line on the visbreaker furnace.
46B	1370	82.3	Voluntary shutdown for general cleaning and repairing.
47	2705	89.0	"
Avg.	1565		

*In determining service factor this long shutdown period due to labor trouble was compensated for by allowing four days for cleaning and repairs and neglecting the remaining down-time.

†$\frac{\text{Onstream time}}{\text{Onstream time} + \text{down-time}} \times 100$

TABLE 2. Comparative Data on No. 2 Cracking Unit.

	Before desalting	After desalting	Improvement (difference)
Service factor, percent	79.9	89.3	9.4
Crude rate, bbl per stream day	38,922	46,111	7,189
Crude rate, bbl per calendar day	31,102	41,184	10,082
Average run length, hr	*702	1,565	863
Down-time, days	73.3	39.0	—34.3
Cleaning exchangers, man-hours	26,813	10,638	—16,175
Cleaning furnaces, man-hours	11,239	9,680	—1,559
Repairing exchangers, man-hours	6,418	3,065	—3,353
Repairing furnaces, man-hours	3,486	1,079	—2,407
†Total for exchangers and furnaces, man-hours	48,956	24,462	—23,494
Average V. B. O. T. transfer-line, temp., F	825	860	35
Approximate average preheat temp., F	605	645	40
Average preheat duty, 10^6Btu per hr	185	244	59

*Run No. 43B was of short duration. If this run were not considered this value would be 783 hr.

†This includes exchangers and furnaces on the unit not directly concerned with the salt problem.

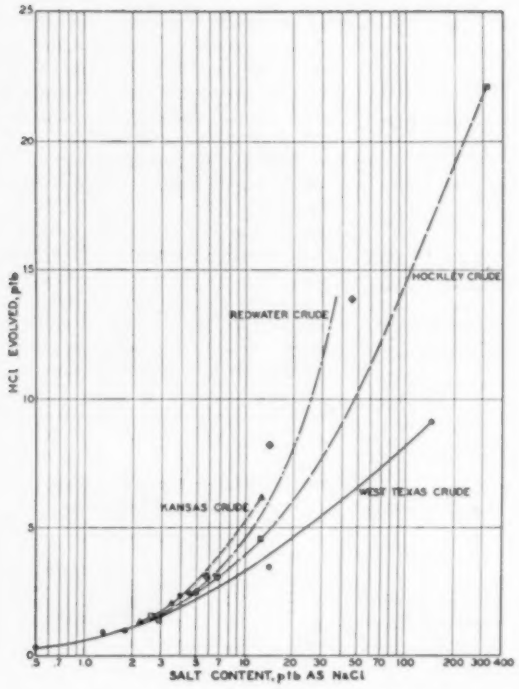


FIG. 9. Amounts of hydrogen chloride evolved, as related to salt content of crude oil.

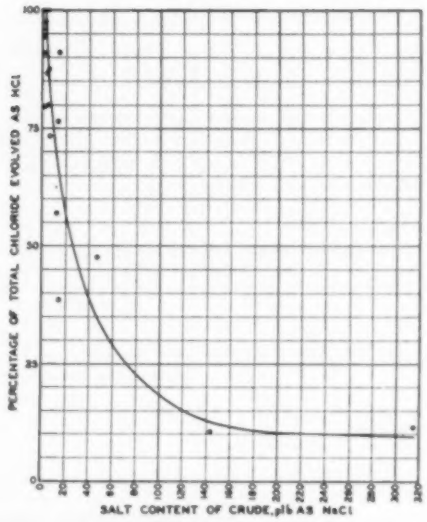


FIG. 10. Total salt, (chlorides) present as compared to the percentage of this total converted to hydrogen chloride.

Connate organic acidity may be reduced and contaminating mineral acidity from crude oil production procedures may be eliminated by adequate desalting procedures, particularly where alkaline wash water is used.

The addition of alkalies such as caustic or soda ash to the desalter wash water frequently is very beneficial, both in facilitating the separation of the emulsion and in extraction of acidic material and solids from the crudes. In certain earlier cases, where specific crudes were charged consistently, it was feasible occasionally to desalt to the then tolerable values, using only alkaline water without demulsifiers.[5]

The background of information on desalting and the broader subject of the colloid chemistry involved is great. Its application is sometimes complicated by the heterogeneous nature of petroleum and the vast quantities of material to be processed. Of knowledge of the subject of emulsions, as of metals, one may say, "Some of it is in books, some of it is still a tradition handed down by the skilled workman to the apprentice. There is even a sense of the nature, or condition, or property of an *emulsion* which cannot be put into words, and is only taught by example to such as have the power to understand."[6]

Analysis

Analysis for the determination of salts of all kinds and other impurities in crude oil has been investigated thoroughly. Proved procedures have been published and accepted by the industry.[7] Generally a sample of crude oil is extracted with distilled water in the presence of solvents such as xylene, benzene and acetone. For difficult extractions a demulsifier may be added to speed the separation. The extract is then analyzed for chlorides by silver nitrate titration, either colorimetrically or electrometrically. Other salts are determined by further analysis of the extract.

Effects of Salts on Refinery Equipment and Operations

There is a great variety of benefits from desalting but there is a common denominator: *More barrels per calendar day (BPCD) throughput.* And generally, the greater the desalting efficiency, the more the barrels. In Fig. 5 petroleum and its contaminator are traced from source to products and the locations where salt takes its toll are indicated clearly.

Storage

In refinery crude oil storage, the accumulation of tank bottoms reduces the amount of storage available and it may affect the amount of crude run by having slugs of water and sediment go to the stills during tank switches. Without reliable desalting the resulting interruptions, slopping of product and readjustment, finally add up to less crude charged. Although normal periodic sampling of crude may show noth-

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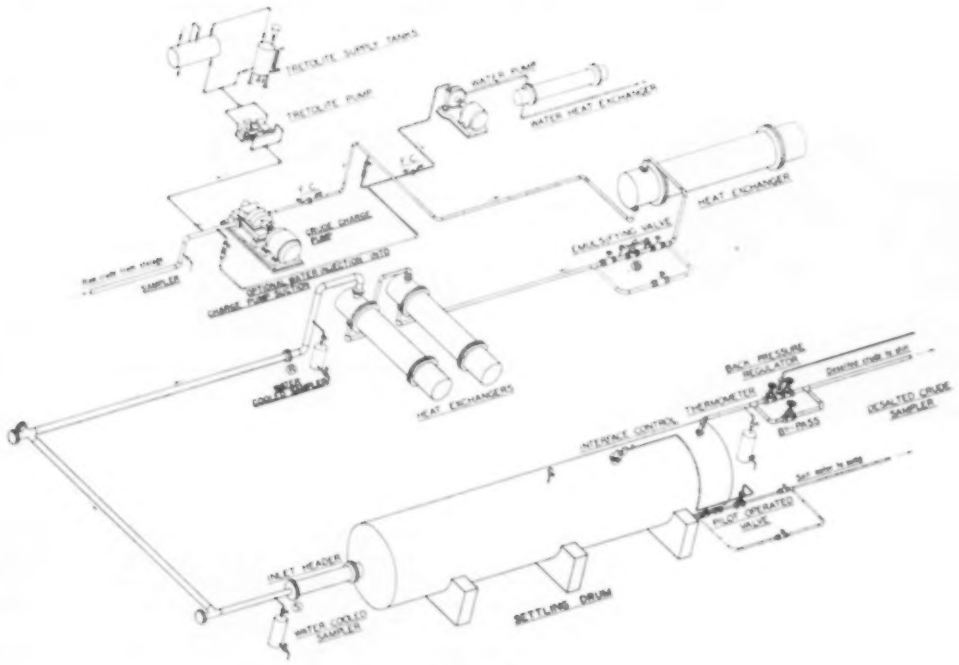


FIG. 11. A typical chemical desalting plant.

ing unusual, erratic still operation can be accounted for by the information supplied by continuous sampling methods.

Fig. 6 shows how slugs of high salt, solids and water enter the refinery stream when tanks are switched. In a Gulf Coast refinery, 60 samples of the charging crude were taken at one minute intervals, starting 15 min before the tank switch was made. Both of the storage tanks contained crude oil from the same source, differing only in that it was stored in separate tanks. These data were taken during a normal tank switching operation.

In an East Coast refinery, samples taken similarly showed peaks up to 30 percent water, although the tank farm had been constructed only a short time before. Desalters protected both systems so that the charge to the still showed only a slight but tolerable increase in salts corresponding to the previous peaks.

Accumulated tank bottoms and refinery slop oil may be recovered by metering moderate proportions, e.g. 3 percent to 5 percent, into the crude being charged to the desalter.

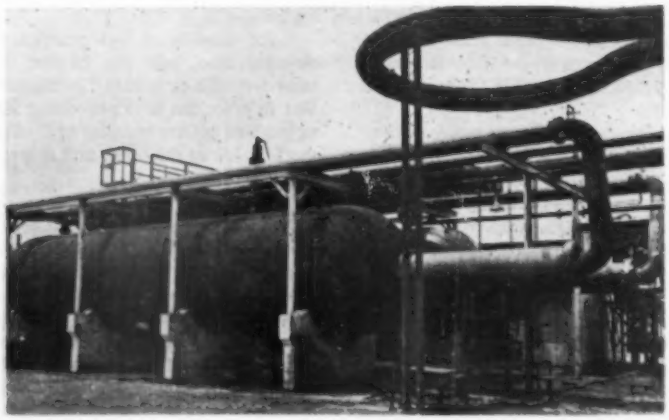


FIG. 12. Parallel chemical desalters in a Gulf Coast refinery, handling 50,000 bbl per day of crudes.

Salt Deposition

Reduction in BPCD due to plugging of equipment and fouling of heat exchange surface imposes a severe penalty upon the refiner who charges salty crude. The loss of crude preheat forces a reduction in charge rate to maintain temperatures. The reduced rate may result in a decrease in fractionation efficiency as well as a loss of charge. Plugging of exchangers, furnaces, visbreakers and fractionators means a shutdown for cleanout. In visbreakers, salt apparently catalyzes the formation of coke. This consequently reduces the heat transfer rate and causes localized heating and eventual rupture of the tubes. Loss of gas oil and gasoline production is the indirect result of tube fouling. Salts may be carried by en-

FIG. 13. Vertical wash tank and horizontal settler at an Illinois refinery.

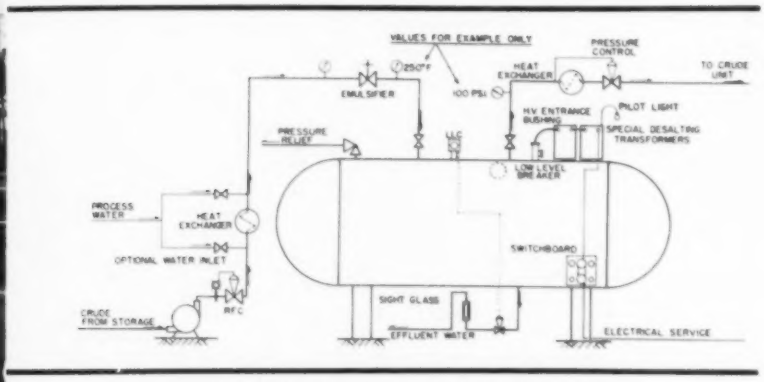


FIG. 14. Flow diagram of a typical desalting unit.

trainment from vacuum towers into products that may be marketed or as charge stocks for other refinery operations; in either case their presence can be damaging.

Fig. 7 presents graphically the run lengths, crude charge rates, visbreaker once-through transfer-line temperatures, and the salt content of the raw and desalted crudes at a Gulf Coast refinery for typical runs before and after desalting. These curves show quite clearly the decided improvement in operation as the result of efficient desalting. The visbreaker once-through furnace coil transfer-line temperature is indicative of the condition of these furnace tubes with relation to salt and accompanying coke formation. After desalting, these temperatures were raised from an average of 825 to 860 F without any indication of accelerated coking but with a decided increase in gasoline yield.

Table 1 summarizes the run lengths and the reasons for the termination of runs before and after the desalter was placed in operation. Fig. 8 shows the loss in crude-preheat duty at No. 2 cracking unit for typical runs before desalting, after improved dehydration in the field, and after the installation of the desalter. Table 2 shows that BPCD charged were increased by 33 percent or 10,000 bbl per day and that maintenance and down-time was reduced to approximately half.

Corrosion

Corrosion of refinery equipment exacts a heavy toll for replacement and maintenance, currently estimated to cost more than eleven cents per barrel of crude processed.[8] Salts were recognized as a source of corrosion resulting from the evolution of HCl in distillation equipment by able investigators, during the early days of the development of desalting, who reported on the chemistry of the process and its damaging effect on equipment.[9] The extraordinarily severe corrosion due to the combination of sulfur compounds (H_2S, mercaptans, etc.) and the hydrochloric acid derived from salts is attributable to an oxidation-reduction reaction wherein HCl reacts with iron to form iron chloride, which in turn reacts with H_2S to produce iron sulfide and more HCl.

$$Fe + 2\,HCl \rightarrow FeCl_2 + H_2$$
$$FeCl_2 + H_2S \rightarrow 2\,HCl + FeS$$

Through hydrolysis of magnesium and calcium chlorides (as distinguished from sodium chloride) has been credited by most authorities as being the source of HCl evolution, an extensive investigation has shown that, in low salt content crudes, more HCl may be evolved than can be accounted for by these two elements alone.[10] With salt contents of a few ptb, almost quantitative evolution of HCl may result. The presence of organic acids was suggested as being a possible influence favoring evolution of HCl from sodium chloride.

From experience with many operating plants, it is known that ammonia consumption for neutralization does not decrease proportionately to salt content; in low salt concentrations ammonia requirements are proportionately higher. Thus a refinery which processes 25,000 BPD with a content of only 5 ptb might be exposed to the corrosive effect of some 62.5 lb of HCl (the equivalent of about 47 lb of iron) per day.[10] The iron loss may be much greater in the presence of H_2S, as mentioned above. For most effective protection against HCl corrosion, salt contents should be reduced to about 1 ptb or less. Fig. 9 and 10 show the relationship between HCl evolution and percentage evolved as functions of salt content.

The equipment most susceptible to corrosion from HCl is that where moisture may be present also: Condensers, exchangers, top trays in fractionators, transfer lines and receivers.

Products

Residual products are the ones most likely to be affected harmfully by salts in the crude charge, since salts are concentrated in the bottoms. Asphalts may fail to pass the solubility test if the crude contains salt. Asphalt shingles have been known to go off color and deteriorate due to the presence of salts. Fuel oil may have excessive ash content due to salts, casing boilers and settings to be damaged by slagging. Fuel for gas turbines should be especially salt-free because of the erosive effects of fused salts upon turbine blades.

Coke must be of high purity for use as electrodes, and this cannot be attained if salt is present in the crude. Salt in coke has also prevented its use in modern boilers because of fouling on the fire side of the tubes and deteriorating effects on linings.

Efficiency of Desalting

The value of high efficiency in desalting has been receiving more general recognition as a result of increase in experience, more accurate refinery design data, higher rates of heat transfer, larger refinery units, longer runs and necessity for accurately scheduled turnarounds. In consequence of this recognition, the refiners' specifications have been ever more demanding. An ap-

proximate overall average for various desalting plants of different types, location, size, crudes, etc., is:

Salt in: 50 ptb Salt out: 2.5 ptb

Removal: 95 percent

Individual plants may vary among themselves rather widely for the variation in average incoming salt is from 10 ptb to 250 ptb. As previously mentioned, spot samples of incoming salt are likely to be extremely high at times.

There is no limit to how low salt may be reduced if the refiner will provide equipment and suitable operating conditions of water, temperature, pressure, rate, etc. At a large North Texas refinery, salt has been reduced from more than 100 ptb to less than .5 ptb consistently for several years, by electrical desalting.

What Crude Needs Desalting?

Today the consensus of refiners is that all crude needs desalting, no longer is economic justification a problem. "The overall effects of excessive salt in crude are: Low crude rate and short runs with excessive down-time and high labor costs, more frequent equipment replacements due to corrosion and excessive strain on equipment. Efficient desalting provides more barrels of crude charged, more effective refinery operation and less operating cost."[11]

Chemical Equipment

Referring to Fig. 11, the chemical desalting process operates as follows:

A chemical proportioning pump injects the recommended dosage of the appropriate chemical into the suction line of the crude charge pump to assure its thorough dispersion throughout the oil. Wash-water (approximately 5 percent per volume of the crude charge rate) is then proportioned into the crude line following the crude charge pump. The oil, demulsifier, and wash-water pass through the primary heat exchangers to attain operating temperature. An emulsifying valve (line-sized globe) is used to secure and control water-to-oil contact.

Following the mixing stage where the brine is associated with the wash-water, the emulsion then passes through the coalescing section (enlarged piping to provide proper settling time and turbulence) where the water droplets, now containing the salt, coalesce to drops large enough to be able to settle out when the mixture enters the desalting vessel. Here it is washed through the water layer and complete separation of the two liquid phases is effected.

Pressure samplers are provided at strategic locations to secure samples during "onstream" operation for observing results as the crude and water pass through the desalting unit. Only standard instrumentation is required since the entire unit operates as part of the conventional refinery stream. Operation is simple and consistent, there is no need for additional personnel. Crudes varying from 14 to 50 API gravity are being processed through these units varying in size from 1000 to 88,000 bbl per day per unit for a total of over 1,500,000 bbl per day, with an average salt removal of 96 percent. The average cost for chemical is 1.3 mills ($0.0013) per bbl of oil. Table 3 gives operating data for a typical plant.

Fig. 12 shows two chemical desalters operating in parallel. The combined streams total 50,000 bbl per day. The coalescing section is comprised of loops of large diameter pipe on racks above the vessels, these connect to larger diameter pipe spools which are "entrance headers." The plant in Fig. 13 has a vertical wash tank between the coalescer and the horizontal settler; it also desalts 50,000 bbl per day of crude.

Electrical Equipment

The qualities that have made electricity the accepted energy supply for industry are characteristic of electric desalters; Reliability, efficiency, economy, effectiveness and versatility. For example, Tidewater's new Delaware City installation processes 130,000 bbl per day of the following crudes in infinitely variable proportions: Iranian, West Texas, Hawkins, Lagomar, Kuwait, Tia Juana, Bachaquero, Wafra, S. Louisiana, slops, and others. The job of this desalter is to receive any crude, as it comes, and without aid or revision, deliver a product freed of salts, water and solids to "The Refinery of the Future"; this it does every day and all day. Electricity alone does it all.

Fig. 15 is a flow diagram of a typical electric desalter installed as an integral part of the refinery. The oil is preheated to a suitable temperature, water is added and dispersed intimately into the electric field where extraneous matter is coalesced along with the dispersion into a continuous stream of effluent water, bearing the impurities with it. Purified oil flows on to distillation. The whole procedure may transpire in minutes, as the operation is essentially dispersion and coalescence, under powerful influences. Each droplet is propelled by electrical force to its rendezvous with a myriad of others; nothing is left to chance.

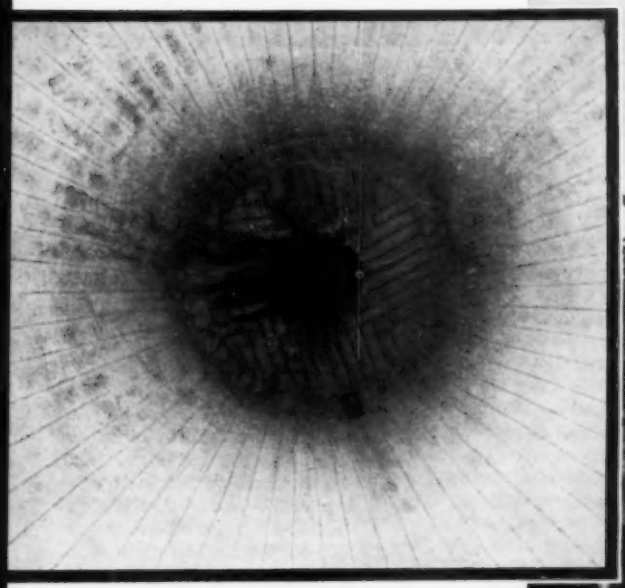
Electrical desalters may be built to almost any refinery requirement of size and pressure. Single units in a variety of sizes and designs process from 2000 bbl per day to 125,000 bbl per day. Designed operating pressure may vary from 30 psi up to that which is necessary to flow the oil through a train of exchangers, heaters and towers. The units are supplied with electricity from the regular refinery distribution system. High voltage transformers and electric controllers are part of the desalter equipment. Sufficient volumetric capacity provides for a uniform discharge rate of clean oil with varying water content of input oil. Fig. 16 illustrates various types.

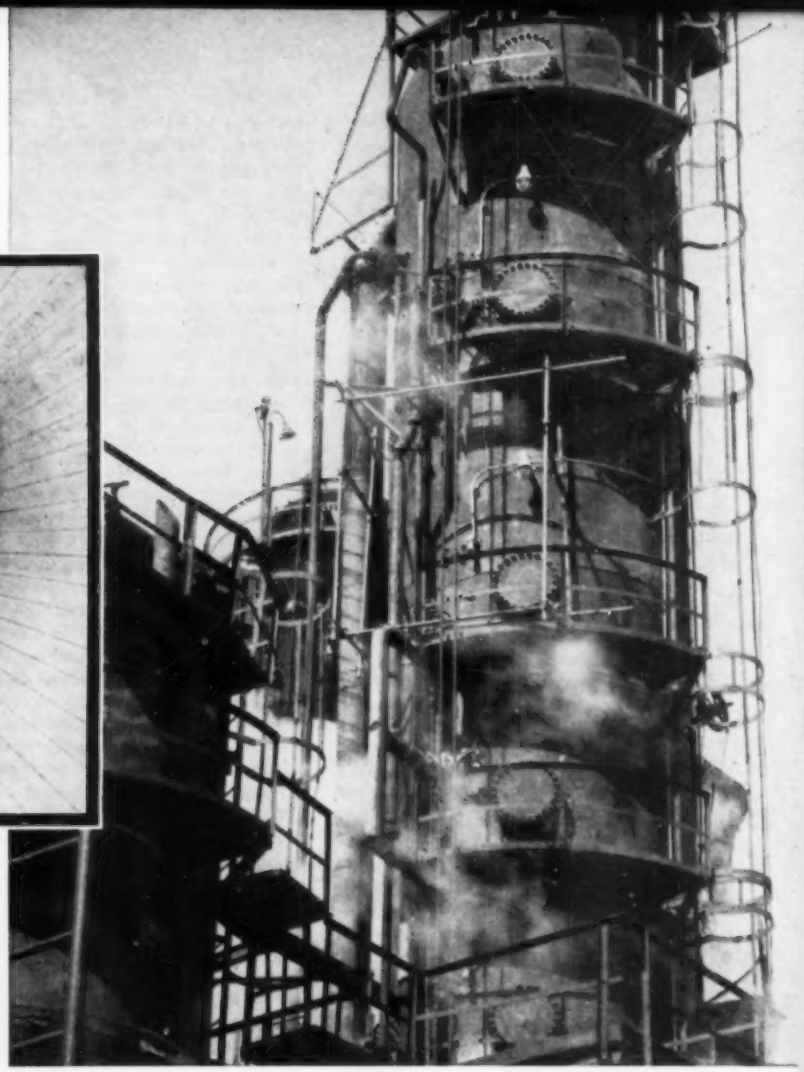
Protective devices are incorporated in the electrical circuit to insure continuity of operation. Reactance units limit current flow to less than breaker settings so that excessive loads due to water slugs do not interrupt the operation, nor can the equipment be overloaded. A low-level device eliminates the electrode voltage if flow is interrupted and the vessel becomes partially empty. All electrical wiring is com-

TABLE 3. Representative Chemical Desalting Plants.

Through Put Bbl/day	Crude Type	Operating Data: Percent Water	Temp. F	Press. psig	Avg. Salt Content: In ptb	Out ptb	Avg. Percent Removal	Chemical Cost, bbl (mills)
15,000	Willimar, Arabian, Refugio, Oficina	5.0	220	85	40	3	92.5	1.2
33,000	Redwater, Mixed	5.0	255	205	50	0	100.0	1.0
25,300	Mid-Continent Mix	4.5	265	175	29	1	96.3	1.0
27,000	Mississippi Mix, Bachaquero	5.0	330	140	220	2	99.0	4.0
13,000	Leduc, Bottineau Slop Oil	4.5	255	240	45	1.0	97.8	2.5
27,500	Mix Kansas	10.0	265	110	28	0	100.0	1.5
35,000	West Texas, Mid-Continent, W. Kansas	3.2	270	170	32	1.0	96.7	1.0
60,000	East Texas, West Texas	3.5	235	225	40	1.5	96.0	1.0
17,500	Hawkins, Mississippi, Arkansas	4.7	250	—	32	3.0	90.5	1.4
21,500	West Texas, Wyoming	5.0	225	116	20	1.0	95.0	1.1
30,000	South Texas	5.0	250	175	60	2.0	96.5	0.6

The fractionation unit on the right is lined for ⅔ of its height with Stainless Steel 410. The flash tower at left is 35% lined with Stainless Steel, primarily in flash zone.





No repair or replacement necessary after six years' service! The vessel shown here has been in continuous service for six years purifying sour gasoline. It is now being switched to another type of service. The condition of the Stainless Steel 410 lining is so good that no repair or replacement is necessary.

Not one single failure of STAINLESS STEEL tower lining for Eastern States Petroleum Company

AT PLANT #1 of Eastern States Petroleum Company, Houston, Texas, high temperature sulfur corrosion caused by sour crude systematically destroyed every carbon steel tower in the plant. As these failures occurred, all towers were replaced with Stainless Steel lined equipment. Since the installation of the Stainless Steel, not one lining failure has been reported.

All new equipment installed since 1949 has also been lined with Stainless Steel and again, no failures have occurred. Most of the Stainless used for this type of application is USS Stainless Steel Type 410.

USS Stainless Steel has long proved that it has the ability to stand up under the extremely corrosive, high temperature, high pressure conditions associated with refinery operation. For this reason Stainless Steel has wide application in all types of refineries.

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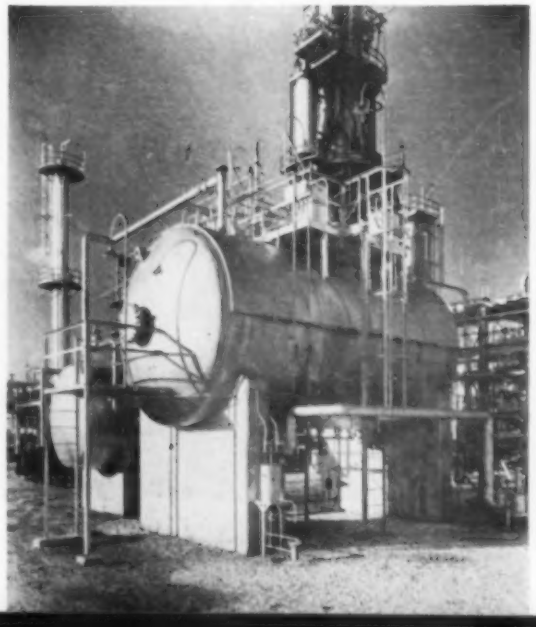
Electrodes are designed and built for maximum reduction of water entrainment in the oil and oil entrainment in the effluent wash water. Clarifying devices further insure an oil-free water bleed.

Operating costs comprise those for electricity, water, instrument air, steam for tracing, and labor. Labor is normally a part-time duty of the stillman and may or may not be charged to the desalter. Electricity will vary with the type of crude, size of plant and power rate. Over a broad average, the cost of electricity is less than 20 cents per thousand bbl treated or less than .2 mills per bbl. For water at 25 cents per 1000 gal the cost is .5 mills per bbl of oil; however, water from other processes such as vacuum unit condensate or cat cracker condensate is used frequently at no charge. The added benefit of recovering suspended oil or dissolved organic material from the water makes for a profitable operation and a pollution preventive. Thus the sum of utility costs for electric desalting is less than 1 mill per barrel, on the average.

FIG. 15. Various types of electrical desalters: Above — Vertelectric, 10-ft diam, throughput capacity about 3000 bbl per day each; Right — Electrospheres, 10 to 36 ft diam, up to 125,000 bbl per day each in minimum space; Below — Cylectric, 10 to 12 ft diam, suitable for high working pressure and capacities of from 10,000 to 100,000 bbl per day.



Summary

Oil, water and salt coexist in nature and production. Their separation may be accomplished chemically or electrically under commercial conditions in simple reliable equipment, to meet strict specifications. The choice is dependent upon conditions that are specific to the installation. Direct benefits are so much greater than the cost, which is nominal, that justification is generally assumed; indirect benefits are significant. The modern refinery design and operation is dependent upon a consistently clean charge.

References

1. D. V. Dow, *Oil Field Emulsions*, Bulletin 250, Bureau of Mines, 1926.
2. Christianson and Horne, *Desalting Crude Petroleum*, U. S. Bureau of Mines, R. I. 3422, October 1938.
3. The Technology of Resolving Petroleum Emulsions, L. T. Monson and R. W. Stenzel in Alexander's Colloid Chemistry, Vol. VI, 535 (1946) Reinhold, N. Y.
4. J. E. Green, A. H. Hall and J. R. Luttrel of Shell Pipe Line Corporation.
5. L. R. Gray, *Petroleum Engineer*, *16*, No. 1 (Oct.) 160 (1944).
6. Sir William Bragg, "Concerning the Nature of Things," Harper & Bros. 1925.
7. Petreco Manual — *Impurities in Petroleum*, Petrolite Corporation, Box 2546, Houston, Texas.
8. API Subcommittee on Corrosion, 1954 Report.
9. Davis, Jones & Neilson, *Oil and Gas Journal*, *37*, No. 2, 62 (1938).
10. G. J. Samuelson, Proc. Am. Pet. Inst. *34* (III) 50 (1954).
11. Report on Desalting of Crude Oil, by W. A. Bonowitz, N. A. Koneman and M. C. Hopkins of American Oil Co., *Petroleum Engineer*, p. 98, Vol. 20, No. 2, November 1947.

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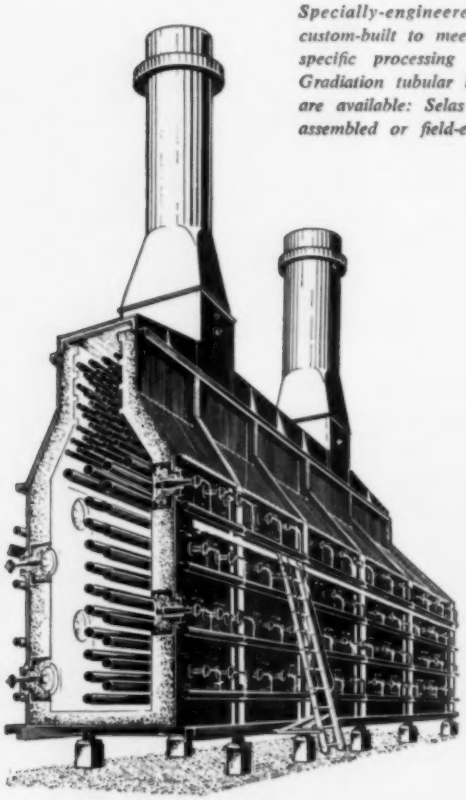

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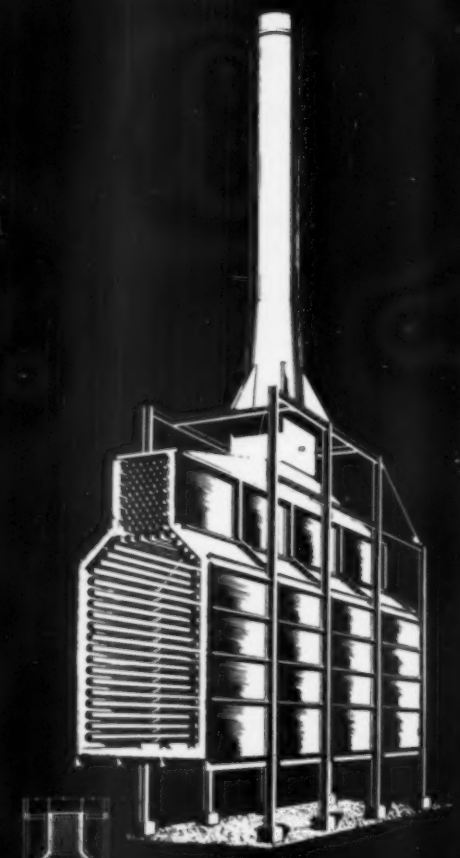

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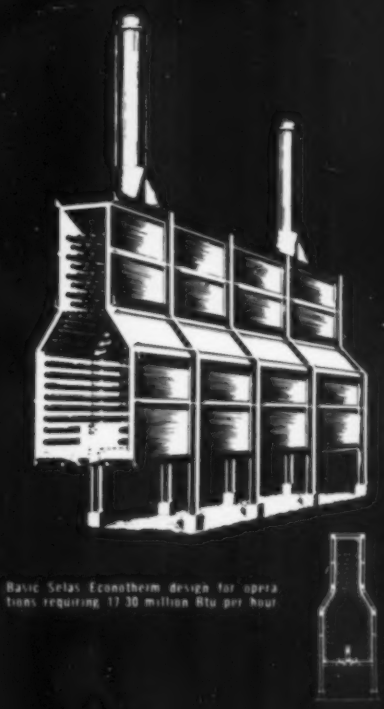
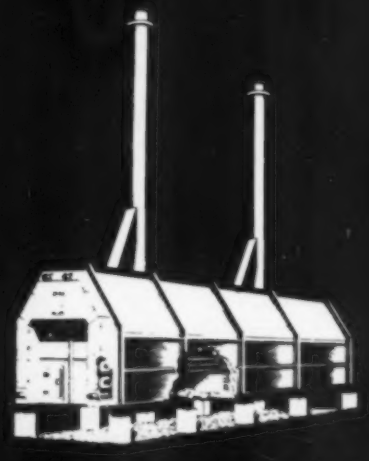


Basic Selas Econotherm design for opera tions requiring 17 30 million Btu per hour



Basic Selas Econotherm design for processing require ments from 8 17 million Btu per hour. A basic design is also available for requirements up to 8 million Btu

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Heat and Fluid Processing Engineers

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SELAS

Bauxite Filters

Boost Alkylate Quality, Save $1000 per day

V. L. Brant
D-X Sunray Oil Company

A BAUXITE treating system has been in service on the alkylation unit at the D-X Sunray refinery in West Tulsa since the fall of 1954. Used to treat the alkylate effluent, quite satisfactory service has been obtained. This processing scheme has resulted in some very definite improvements in our operations, including:

1. Fouling and corrosion have been greatly reduced throughout the entire liquid effluent fractionating system.
2. The deisobutanizer overhead recycle stream is dry.
3. Operating costs for treating the effluent have decreased.
4. The tetraethyllead susceptibility of the alkylate has greatly improved.

Reduction in fouling and corrosion has greatly reduced down time and maintenance costs. Even though we have had the filters in service since the fall of 1954 we have not had an opportunity to actually test the effectiveness of cleanup in the deisobutanizer tower. We have had over a six months' run without any decrease in the efficiency of the tower when the plant was shut down for reasons other than fouling. It is our standard procedure that whenever the plant is down we chemically clean the towers. Before installation of the bauxite treaters we were getting only two to four week runs on this tower. At the rerun tower we have put the reboiler back into service and are getting several months' run before it has to be taken out of service for cleaning. We have had to replace some risers, caps, and frogs only one time in this period and this was due mainly to a condition existing before the filters were installed. Overall, we estimate that our maintenance and down time due to corrosion and fouling has been reduced 85 percent. This in round figures amounts to about $175 per day.

Corrosion and Fouling Headaches

In order to fully appreciate what bauxite filters have done for us, it will be necessary to describe the fouling and corrosion history of our plant. D-X Sunray put its first sulfuric acid alkylation plant onstream in the fall of 1950. This plant contained a Kellogg cascade two-stage reactor with a design capacity of 800 bbl per day of total alkylate. The liquid reactor effluent was caustic washed after heat exchange with fresh feed and recycle and preceding the deisobutanizer tower. The fractionation system for the liquid effluent consisted of a deisobutanizer, debutanizer, and a rerun tower. We presently have a three-stage reactor and manufacture 3000 bbl per day of total alkylate.

The problem of fouling was intensified with increased throughput. Immediately after start-up of the plant in 1950, it became apparent that we would have serious fouling and corrosion in the rerun tower. As we increased production to about 1800 bbl per day of total alkylate this condition became so severe that the rerun tower was down every 6 to 10 days to clean the tube bundle in the reboiler and frequently to replace the risers, caps, and frogs in the tower proper. This condition became intolerable even with the best inhibitor system we could devise.

We finally changed over to open steam in the fractionator and took the reboiler out of service. This resulted in the tower remaining onstream longer, but at a sacrifice of fractionation efficiency, resulting in loss of light alkylate yield. From the beginning, we had some fouling upstream of the rerun tower, but it was of a much less severe nature and could be tolerated. However, as we increased production to about 2200 bbl per day of total alkylate this also became intolerable. The deisobutanizer, which is the heart of any alkylation plant, was fouling severely. We were getting from two to four week runs before the purity of the overhead stream was dropped to a point where it was necessary to shut down for cleaning this tower. We would chemically clean the tower and open and inspect. Frequently we had to remove the trays for mechanical cleaning.

Laboratory Studies Helpful

Our laboratories had been actively studying the problem throughout this period. Their initial work centered around secondary measures, such as inhibitors and emulsifiers to aid in con-

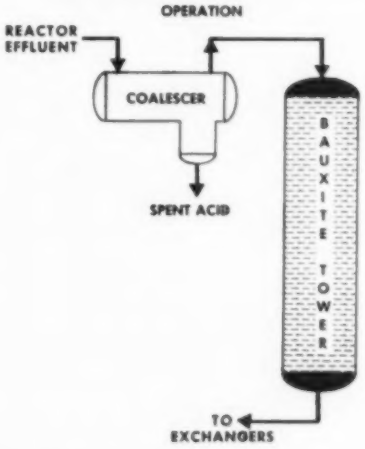
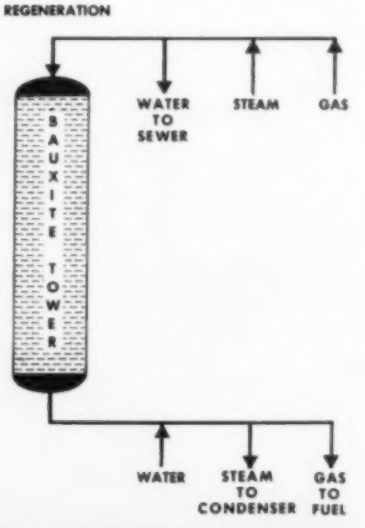


FIG. 1. Flowchart of bauxite filter unit in alkylate system.



†Presented to Western Petroleum Refiners Association regional technical-industrial relations meeting, Wichita, Kansas, June 21, 1957.

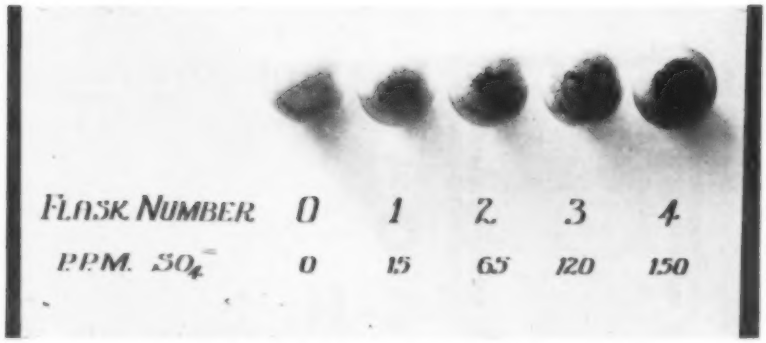


FIG. 2. Deposit left in flasks under different operating conditions.

trol of the problem. These measures gave some relief but they became inadequate as throughput increased. The laboratories then became active in developing a means of removing the corrosive and fouling constituents from the liquid effluent. Obviously the caustic wash system was not removing all the corrosive constituents from the alkylate. Investigation revealed that caustic washing was removing the acid and acid esters, however, some neutral sulfur bearing esters remained in the hydrocarbon. Some of these neutral esters were later decomposed in the fractionation system, leaving a carbonaceous deposit and causing an acid condition. Other more stable neutral esters survived the temperatures of the fractionating system and appeared in the alkylate product, causing loss in tetraethyl lead susceptibility. Also, it was found that the fouling tendency of the alkylate was, in most cases, increased by caustic washing due to the solubility and entrainment of sodium compounds. After much investigation and many pilot plant tests, bauxite treating was found to be the answer.

How the System Works

The treating system consists essentially of a coalescer and two bauxite contacting beds as shown in Fig. 1. They are located in the liquid effluent system immediately following the reactor, and before heat exchange with the recycle and fresh feed. The liquid effluent passes first through a glass wool coalescer which separates the finely suspended particles of acid from the hydrocarbon. This operation removes about 75 percent of the insoluble acid. Next, the liquid flows down through one of the bauxite treaters were the remaining soluble and insoluble acids and other sulfur bearing materials are removed. The hydrocarbon leaving the treaters is essentially free of all corrosive and fouling constituents. The onstream life varies from 3000 to 6000 bbl of reactor effluent per ton of bauxite, depending upon the quantity of sulfur bearing materials to be removed. The regeneration cycle consists of water and steam desorption of the sulfur-bearing materials, followed by natural gas drying of the bauxite. The bauxite is regenerated in place and can be used repeatedly. Bauxite is added to the filters only as necessary to replace losses during the regeneration cycle. The alkylate leaving the filter is not treated further, and the pre-existing caustic wash system remains only as a wide space in the line.

Improvements Realized

Fig. 2 is a visual gage of the effectiveness of bauxite treating. The picture shows the deposits left in a 100 ml distillation flask after boiling 100 cc of weathered reactor effluent to dryness. Flasks 3 and 4 are typical of untreated reactor effluent. Flask 2 is typical of the residue that is left in the flask from caustic washed effluent. Flask O showing no deposit is typical of a bauxite treated reactor effluent. Flask 1 is the control point at which we switch filters.

The effluent from the bauxite treaters will have an O flask rating for nearly the complete cycle. The transition from "O" to "1" flask rating takes place over less than 25 percent of the onstream period. The mechanism of the filters is one of preferential adsorption. At the beginning of the cycle the bauxite adsorbs sulfuric acid, acid esters, and neutral esters. As the bed becomes loaded with these sulfur-bearing materials, it will start desorbing the neutral esters. It is at this point that the flask will begin to show deposit. These are neutral esters and do not show any acidity by normal titration methods. The beds have a large capacity for acid and acid esters. We have, as a matter of fact, purposely left a filter onstream for as long as 10,000 bbl per ton of bauxite without any show of acid in the treated product.

Below the flasks in Fig. 2 you will note the approximate parts per million of sulfate represented by the deposits. I might caution here that ordinary sulfur determination methods are not sensitive enough for this test. We used an alcoholic potassium hydroxide digestion method, followed by quantitative sulfate determination. A typical charge sample would vary upward to 120 ppm. A typical caustic washed sample will contain about 65 ppm. The flask representative of the onstream period shows no sulfate. Over the last 25 percent of the cycle, it gradually increased to 15 ppm. These tests show clearly the relative corrosion and fouling tendencies of the various samples.

Water Content Reduction

The water content of the isobutane recycle stream has been reduced 200 lb per day, resulting in an acid catalyst savings. Before installation of the bauxite treaters the overhead reflux drum at the deisobutanizer tower also served as a water separator. This water was introduced into the system by the caustic and water wash operation. The recycle stream, saturated at the conditions of the reflux drum, contained approximately 300 ppm of water. We calculate from the equilibrium water content of bauxite that the recycle stream now has a water content of less than 10 ppm. The water content is so small that we are unable to get an accurate determination by conventional methods. The difference in water contents amounts to approximately 200 lb per day. Considering that the useful range of acid catalyst is from 99 to 93 percent, this means a savings of 3300 lb of acid per

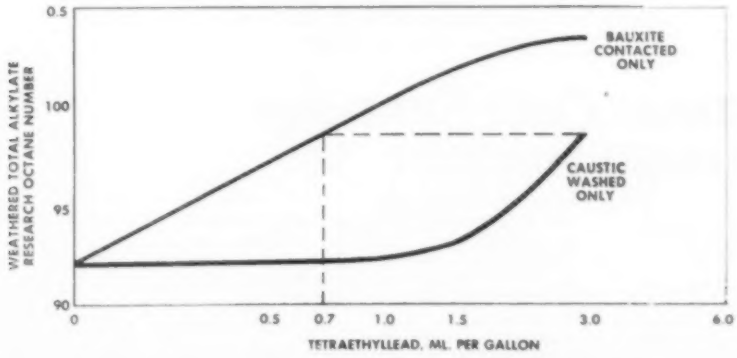


FIG. 3. TEL susceptibility of alkylate with and without bauxite filtration.

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day, and at 1 cent per lb would mean $33 per day savings.

The total cost for treating the effluent has been reduced. In this case we are not able to separate the costs of the liquid effluent system from the costs of the refrigerator vapor effluent system. However, there has been no change in the refrigeration vapor effluent system, and any difference in costs was attributed to the bauxite treating. The total costs for caustic treating and corrosion inhibitors before installation of the bauxite filters was 2.6 cents per bbl of total alkylate. The comparable costs, using the bauxite treaters, is only 0.7 cents per bbl of total alkylate. This is a savings of 1.9 cents per bbl of total alkylate or a total savings of $50 per day in our system.

Octane Rating Boosted

Fig. 3 shows the comparison of F-1 octane rating of caustic washed and bauxite treated alkylate vs milliliters per gallon of tetraethyl lead addition. You will note that for the caustic washed alkylate no lead appreciation was obtained until after 1¼ ml per gal of tetraethyl lead addition. The bauxite treated sample showed an immediate response. When the product is used as motor alkylate, this means a savings of $600 to $700 per day in tetraethyl lead.

D-X Sunray's experience could be summarized as follows:

1. We have successfully used the bauxite treating system for two and one-half years.
2. We have reduced our maintenance and down time costs 85 percent for a savings of $175 per day.
3. We have reduced neutralizing and inhibiting costs $50 per day.
4. We have reduced the water content of the recycle isobutane, resulting in a savings of approximately $33 per day in acid catalyst.
5. By improving the lead susceptibility of the alkylate we realize up to $600 or $700 per day in tetraethyl lead savings, when the alkylate is used in a motor blend.

The total savings to us amounts to $258 per day in operating and maintenance costs plus an additional $600 to $700 per day when the total alkylate is used in a motor blend. This may not be typical of all refineries, since the figures were based on our situation where we were operating at 300 percent of design capacity. This, we are sure, increased our fouling and corrosion problems above that which would be normally expected. However, we do feel that it would not be feasible to operate at our present throughput without the bauxite filters.

This process is licensed by the M. W. Kellogg Company. ★ ★ ★

Octane Rating Up in Many Cities, Slack Off Elsewhere

Gasoline on sale at service stations in August showed national weighted averages of 98.1 octane number for premium and 90.9 octane number for regular, according to the latest monthly survey of antiknock quality compiled by Ethyl Corporation.

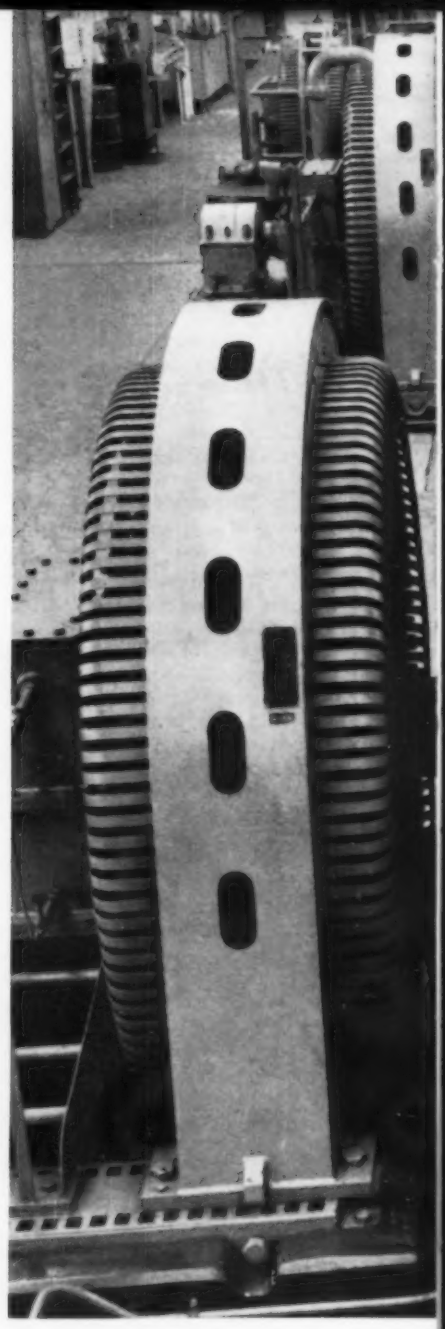
Premium average was 0.1 octane number below the July average. Regular average was unchanged from its July level. Compared with a year ago, the premium average was 1.1 octane number higher and the regular average was 0.8 octane number higher.

Average tetraethyl lead contents in August were 2.62 ml per gal of premium gasoline and 2.19 ml per gal of regular gasoline.

Twenty-four of the 57 cities in Ethyl's survey reported increases over July in the average octane number of their premium gasoline. Twenty-two cities reported decreases and 11 cities remained unchanged. In regular gasoline, 19 cities reported increases over July in the average antiknock quality, by 0.5 octane number or higher. Twenty-eight cities reported decreases while 10 cities were unchanged.

For companies marketing more than one grade of premium, the survey showed a range of 100.0 to 101.5 octane number for the highest grade, on the basis of 37 samples in 19 cities.

	Premium Gasoline			Regular Gasoline		
	Aug. 1957	July 1957	Aug. 1956	Aug. 1957	July 1957	Aug. 1956
Albuquerque, N. M.	97.9	97.7	96.5	88.0	87.9	86.2
Amarillo, Tex.	98.2	98.2	97.0	89.3	89.4	88.0
Atlanta, Ga.	98.1	98.1	97.2	89.8	90.4	89.7
Bakersfield, Calif.	97.4	97.3	96.3	87.8	87.5	86.2
Baltimore, Md.	98.4	98.8	97.4	92.6	92.7	91.6
Billings, Mont.	95.7	95.9	94.1	88.1	88.3	86.6
Birmingham, Ala.	98.6	98.5	97.7	90.0	90.0	89.5
Boston, Mass.	99.0	99.0	97.5	92.8	92.8	91.8
Buffalo, N. Y.	98.9	98.8	97.6	92.4	92.7	91.8
Casper, Wyo.	97.2	97.2	94.0	88.0	87.6	86.1
Central Mich.	97.8	98.2	96.9	91.7	91.8	91.0
Charlotte, N. C.	98.1	98.4	97.3	89.8	89.8	89.5
Chicago, Ill.	98.3	98.1	97.0	91.7	91.4	90.5
Cincinnati, Ohio	98.5	98.4	97.2	91.7	91.8	91.3
Cleveland, Ohio	98.5	98.7	96.7	91.7	91.9	91.6
Corpus Christi, Tex.	98.5	98.6	97.6	89.8	89.8	89.0
Dallas-Ft. Worth, Tex.	98.5	98.3	97.4	89.7	89.7	88.7
Davenport, Iowa	98.6	98.4	96.2	90.6	90.4	88.0
Denver, Colo.	95.0	94.8	93.7	86.3	85.8	85.1
Des Moines, Iowa	98.3	98.4	96.2	89.3	89.4	87.8
Detroit, Mich.	98.4	98.5	97.2	92.2	92.1	91.6
El Paso, Tex.	97.8	97.9	96.8	88.6	88.1	86.1
Fargo, N. D.	98.1	98.3	95.8	89.6	89.3	88.4
Hartford, Conn.	98.9	98.9	97.6	92.7	93.1	92.3
Houston, Tex.	98.0	97.9	97.1	89.5	89.5	88.8
Indianapolis, Ind.	98.4	98.4	96.9	92.0	92.1	91.3
Jackson, Miss.	98.5	98.4	97.2	89.7	90.0	89.3
Jacksonville, Fla.	98.4	98.4	97.2	91.1	91.1	90.6
Kansas City, Mo.	98.6	98.5	96.0	89.6	89.7	88.5
Little Rock, Ark.	98.9	98.8	97.6	89.7	90.0	89.0
Los Angeles, Calif.	97.8	97.5	96.6	87.9	88.0	86.3
Louisville, Ky.	97.7	97.9	96.7	90.6	90.9	89.8
Memphis, Tenn.	98.8	98.6	97.0	90.0	90.3	89.4
Midland, Tex.	98.2	98.4		88.4	88.3	
Milwaukee, Wis.	98.5	98.3	97.2	92.4	91.9	91.6
Minneapolis-St. Paul, Minn.	98.4	98.8	96.4	90.4	89.8	88.4
Newark, N. J.	98.9	99.0	97.1	92.5	92.7	92.5
New Orleans, La.	98.3	98.2	97.5	89.7	89.5	89.0
New York, N. Y.	98.7	98.9	97.7	92.8	92.9	91.9
Northwest Pennsylvania	98.0	98.1	96.3	92.8	93.1	91.7
Oklahoma City, Okla.	98.2	98.0	96.4	89.6	89.1	88.6
Omaha, Neb.	98.0	98.0	96.0	89.3	88.8	88.4
Philadelphia, Pa.	98.2	98.4	97.2	92.5	92.5	91.9
Phoenix, Ariz.	97.8	97.8	96.7	88.5	88.7	86.5
Pittsburgh, Pa.	98.3	98.5	97.6	92.4	92.8	92.0
Portland, Ore.	97.7	97.6	96.8	88.8	89.0	87.2
Richmond, Va.	98.7	98.6	97.3	92.0	92.3	91.5
Salt Lake City, Utah	94.3	94.3	93.0	84.0	84.5	81.9
San Antonio, Tex.	98.5	98.1	97.2	89.3	89.2	88.7
San Francisco, Calif.	97.8	97.6	96.7	88.3	88.2	86.7
Seattle, Wash.	97.3	97.6	96.4	88.0	88.8	87.0
Shreveport, La.	99.0	98.8	97.8	89.6	90.0	89.1
Spokane, Wash.	97.1	97.2	96.0	88.3	88.3	86.7
St. Louis, Mo.	98.1	98.1	96.2	91.2	91.4	88.5
Toledo, Ohio	98.3	98.4	97.2	92.1	92.1	91.4
Tulsa, Okla.	98.6	98.4	96.8	89.5	89.4	88.8
Wichita, Kans.	98.1	98.3	96.1	89.3	89.2	88.0



Cooper-Bessemer 2-cylinder FM's compressing ammonia at the Tuscola plant of U. S. Industrial Chemical.

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This installation at the Tuscola, Illinois plant of U. S. Industrial Chemical Co., a division of National Distillers and Chemical Corp., is typical of the many processing plants using reliable Cooper-Bessemer compressors.

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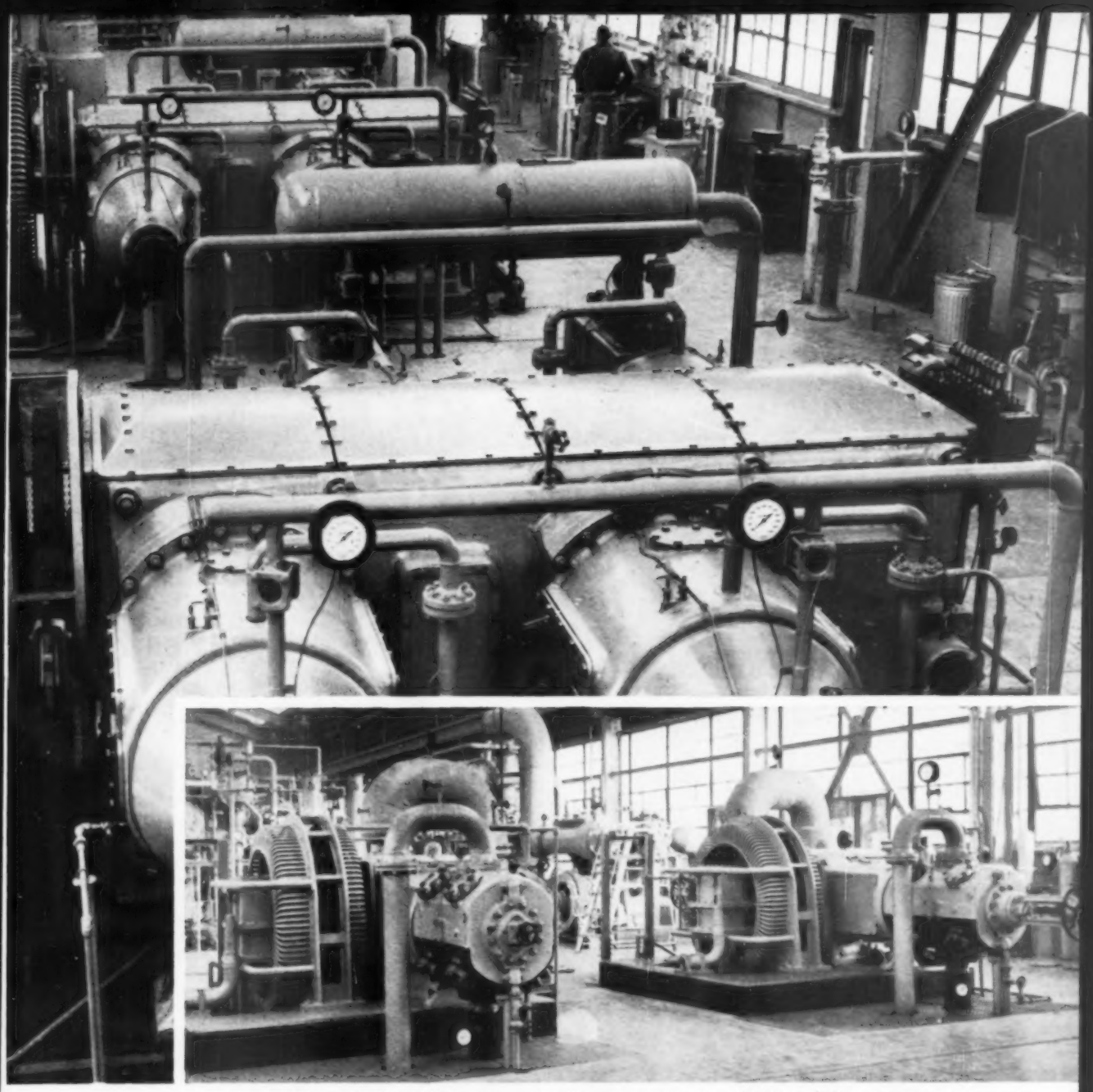
Available from 200 to 6000 horsepower, each M-Line compressor unit is engineered to meet specific requirements with extreme efficiency and at the lowest possible cost. The nearest Cooper - Bessemer office will gladly furnish detailed information.



Two 1500 hp motor-driven JM compressors handling compression of synthesis gas, before conversion to ammonia.

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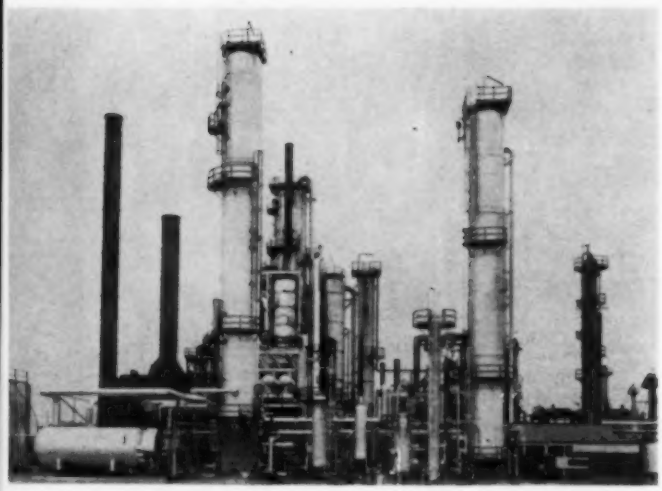
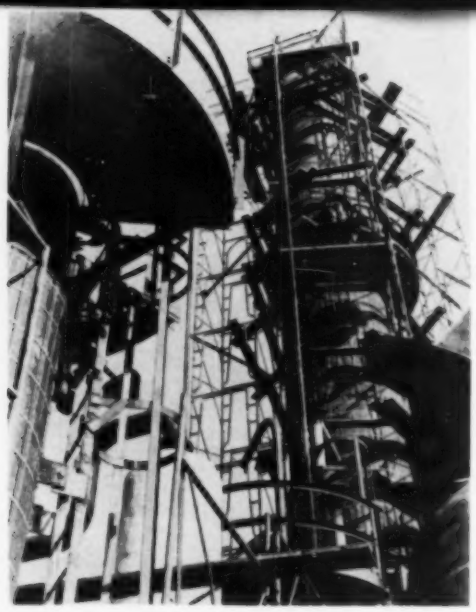


First UOP Rexformer is onstream at Aurora Gasoline Company's Detroit refinery. The unit is designed to produce 5500 bbl per stream day of 98 Research octane clear blending stock for motor fuel.



Column in Rexformer group has been covered with mineral wool blankets which are secured by circumferential steel bands. Note the vertical ribs in lath on outer blanket face and the tight joints between blankets. Layer of white mineral wool insulating-finishing cement has been applied at top of column.

Permanent Wool Overcoats Save Heat

D. Paul Larer
Field Engineer
Baldwin-Hill Company

Now white "Super Powerhouse" cement covers the column at the left. The tower at the right has received mastic weatherproofing, awaits aluminum paint finish.

TEMPERATURE control and prevention of heat loss are becoming increasingly important considerations in the design and construction of petroleum processing equipment. Operating temperatures requiring extremely close control and the higher cost of Btu's make efficient, effective thermal insulation of heated equipment a must. At the Aurora Gasoline Company's Detroit refinery, jackets of spun mineral wool blankets are saving heat — and thus dollars — in the operation of the first UOP Rexformer to be put onstream in this country.

The new 5500 bbl per std day Rexformer, designed by the Universal Oil Products Company of Des Plaines, Illinois, produces Rexformate having a 98 or higher Research octane clear. Addition of 3 ml TEL per gal gives a fuel of 102 octane or higher on the new Wiese scale.

Blankets Selected

Spun mineral wool blankets were selected as the basic material for insulating the new units because of their thermal efficiency and good mechanical properties. In addition, their flexibility enables them to conform to the unit's cylindrical surfaces and their availability in large sizes, simplifies handling.

Blankets composed of felted mineral fibers were selected because the long spun fibers provide good fiber interlock, thus good mechanical stability during handling.

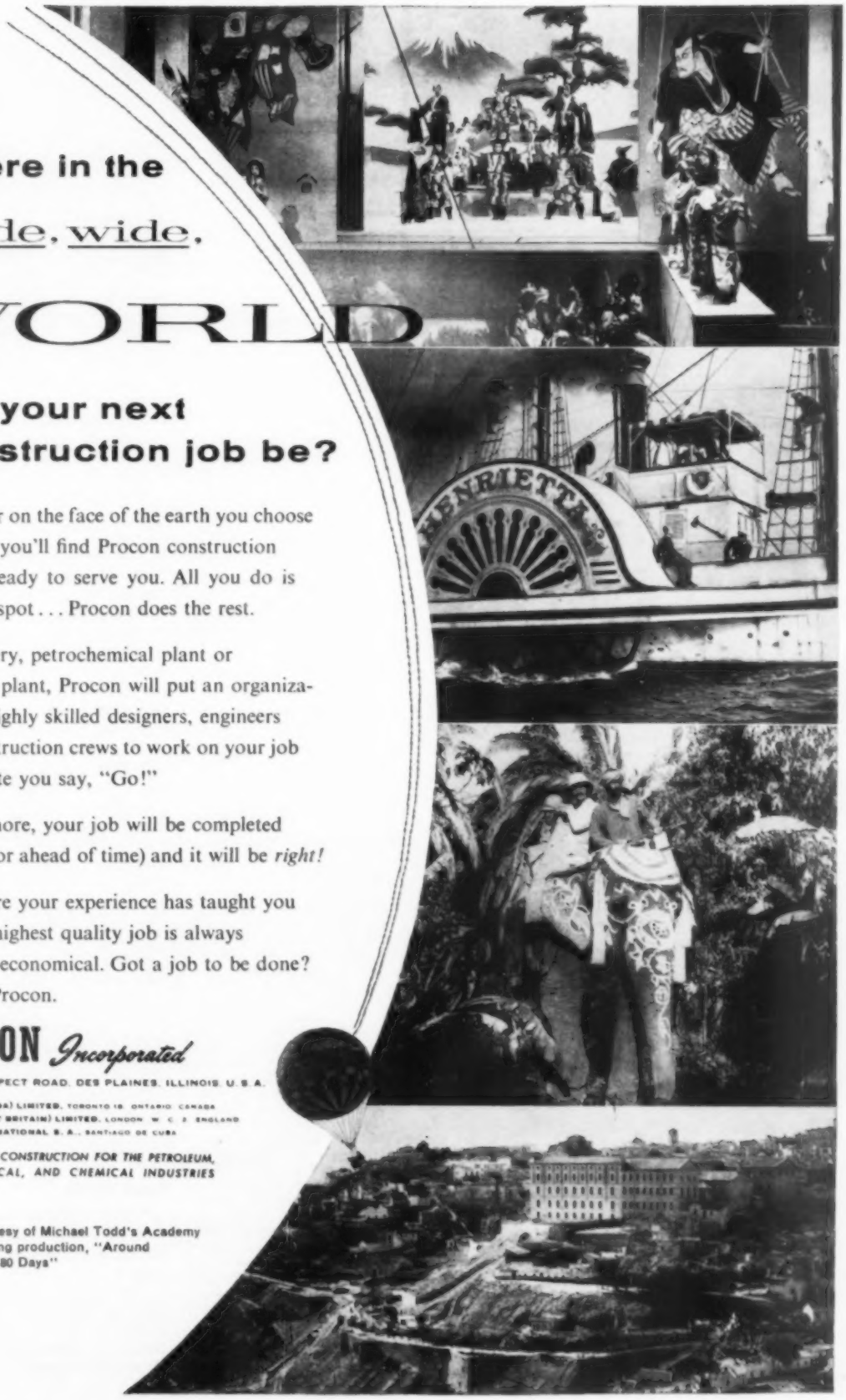
Two-inch thick blankets, 96-in. long and 24-in. wide, were used to provide the greatest possible surface coverage per blanket. In these blankets, the mineral wool is felted between a 1-in. wire mesh and a rib-lath with ⅜-in. ribs. Compared to standard expanded metal lath the rib-lath provides a much stiffer, smoother outside surface, with little of the compression which causes wavyness.

Other Materials

Other materials used to tailor the weatherproof Rexformer overcoat were: 1-in. thick mineral wool blankets in the same size and design as the 2-in. variety; loose mineral wool; white mineral wool insulating-finishing cement and fibrated asphaltic emulsion and galvanized sheet steel.

Materials required to apply the insulation and its protective raincoat were: 1-in. wire mesh, galvanized after weaving; 2 by 2-in. steel angle supports; ½ by .020-in. steel strapping; and 16-gage wire.

Because it would be ultimately covered and its appearance not a factor, conventional insulating cement might have been used rather than the combination insulating-finishing cement. The insulating-finishing cement was chosen for its quick setting properties and its immediate weather resistance.



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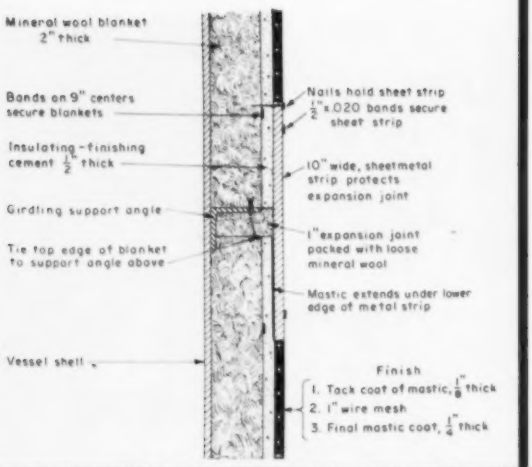
WORLD-WIDE CONSTRUCTION FOR THE PETROLEUM, PETROCHEMICAL, AND CHEMICAL INDUSTRIES

Photos courtesy of Michael Todd's Academy Award winning production, "Around the World in 80 Days"


Mineral wool blanket 2" thick
Bands on 9" centers secure blankets
Insulating-finishing cement ½" thick
Girdling support angle
Tie top edge of blanket to support angle above
Vessel shell
Nails hold sheet strip
½" x .020 bands secure sheet strip
10" wide, sheetmetal strip protects expansion joint
1" expansion joint packed with loose mineral wool
Mastic extends under lower edge of metal strip
Finish
1. Tack coat of mastic, ⅛" thick
2. 1" wire mesh
3. Final mastic coat, ¼" thick

Cross section of insulation construction showing application details and the expansion joint.

Insulating-finishing cement is applied to a small horizontal tank in the Rexformer group. Gray when applied, the cement dries to a white finish. Note detail of blanket rib lath.

Application

Thermal efficiency and service life of an insulating barrier depend to a great extent upon its construction. The insulation must be firmly secured to the hot surface and, if outdoors, must be positively protected from the elements. However, since application costs are a large proportion of overall insulation cost, the method of application should be as straight-forward as possible in order to achieve the desired thermal efficiency and life without maintenance.

The girdling-ring method of application was used to secure the insulation on the two main columns of the Rexformer. Steel angles were welded horizontally around the circumference of the vertical columns at 12-ft, 1-in. intervals. Thus each ring of angles provided a ledge for the support of the insulation above it. Applied with their long axis vertical, paralleling the axis of the cylinder, one and one-half 96-in. blankets were required to cover the vertical distance between angles, leaving an approximate 1-in. space between the top blanket and the support angle immediately above it. After application of a complete layer of blankets between adjacent angles this 1-in. space was stuffed with loose mineral wool to form a vertical expansion joint. The wires, looped through the blanket rib lath and tied to the angle above through holes previously drilled for the purpose, helped support the top row of blankets.

The required circumference of the insulation was computed using the vessel diameter plus twice the total insulation thickness (in this case 4-in.) rather than mean insulation thickness. Thus, a small surplus of material was provided in the blankets encircling the column. This surplus had the effect of providing a very tight fit between adjacent blankets, eliminating the need for lacing the vertical joints. The surplus also helps to accommodate circumferential thermal expansion.

Blankets were applied to the column with their horizontal joints staggered and laced with tie wire. They were finally secured with encircling ½ by .020-in. galvanized bands spaced 9-in. center-to-center.

Finish

A ½-in. layer of quick drying, white mineral-wool insulating-finishing cement was then applied over the blanket rib-lath. Care was taken that none of it extended into the expansion joint. The cement was not finish troweled since a slightly rough surface was desired to receive the weather coat.

Expansion joints were protected from the weather with 10-in. strips of 20-gage galvanized sheet steel applied over the dried cement. The sheets were nailed, at their top edge, to the blankets and each row was permanently secured in place with two steel bands.

Between expansion joints the remainder of the insulation surface was weatherproofed with asphaltic mastic. A ⅛-in. tack coat of the mastic was applied over the cement, extending up under the lower half of the 10-in. steel strip. Next, wire mesh was stretched taut around the vessel between the sheet metal strips, pressed firmly into the still tacky asphalt, the mesh sections were tied together at meeting edges but not tied or fastened mechanically in any way to the blanket, vessels or any other material or component. The weatherproofing coat was completed with a ½-in. layer of the asphaltic mastic over the mesh.

Small Vessels

Smaller vessels and heat exchangers in the Rexformer group were insulated and weatherproofed in substantially the same manner. However, on these smaller units neither angle supports nor expansion joints were required. Nor was the sheet metal expansion joint covering necessary. As on the larger, vertical main columns, blankets were applied with their length paralleling the vessel axis and secured with steel strap girdles. Mastic and mesh weatherproofing procedures on these smaller vessels were the same as previously described.

Final Finish

Upon completion, all units were painted with aluminum paint to give them an attractive finished appearance.

The erection and installation of this first Rexformer unit was performed entirely by Aurora refinery personnel, under the supervision of Universal Oil Products Company. ★ ★ ★

The Author

A native of Pennsylvania, D. P. Lorer joined Baldwin-Hill in 1955 and represents the company as a field engineer in Michigan, northern Ohio and northern Indiana. He holds a BS in chemical engineering from Case Institute of Technology, Cleveland, Ohio. A meteorologist in the Army Air Corps during World War II, he was recalled to service during the Korean War to serve in Tokyo with the Military Transport Service. Between wars Lorer was a project engineer and production supervisor with General Foods Inc., Battle Creek, Michigan. From 1952 to 1955 he was employed as a consultant in the design and selection of commercial air conditioning equipment and systems.

A member of the American Society of Heating and Air Conditioning Engineers, he is also a registered professional engineer (mechanical) in the State of Michigan and a member of the National Society of Professional Engineers. As a mechanical engineer specializing in heating with a chemical engineering educational background he is especially suited to discussing insulation problems in refining and petrochemicals.

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Part 2 | *Hydrogen Peroxide via Direct Oxidation of Hydrocarbons; via Oxidation of Aliphatic Alcohols.*

Peter W. Sherwood
Chemical Engineer, White Plains, N. Y.

B. Hydrogen Peroxide by Direct Oxidation of Hydrocarbons

In the chain of reactions which make up the combustion of hydrocarbons, hydrogen peroxide appears as an unstable intermediate product. Processes for the production of hydrogen peroxide by this route must be directed toward two objectives: (a) Conditions which will lead to maximum hydrogen peroxide formation, and (b) removal of the combustion products from the reaction zone before hydrogen peroxide decomposition exceeds its rate of formation.

Saturated hydrocarbons must be used as feed. Among the lower paraffins, best experimental results have been obtained with propane. Methane yields only a small amount of hydrogen peroxide. Conversion of ethane calls for higher temperature (above 450 C) than propane (350 C +) and hydrogen peroxide yield is smaller from the lower hydrocarbon. Use of butane and higher hydrocarbons is complicated by the formation of appreciable amounts of aldehydes which make recovery of pure hydrogen peroxide difficult. But this by-product formation may be minimized by proper control of reaction conditions, as we shall see.

The following overall equation applies for the desired reaction of propane with oxygen:

$$C_3H_8 + O_2 \rightarrow C_3H_6 + H_2O_2 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

Reaction is carried out in the absence of catalyst. Performance is influenced by eight primary operating variables. In the following discussion we shall consider their effect.

(1) **Feed ratio.** At very low ratios of hydrocarbon:oxygen, excessive amounts of organic peroxides are formed. Minimum practical volumetric ratio is 4:1. It is important to note that this ratio is already above the explosive limit of the system.

Yield of hydrogen peroxide is improved further by raising the feed ratio to about 8 or 10:1. This is the optimum operating range. Above it, yield does not increase significantly while the resulting product dilution and the large reaction volumes impose an unjustifiable economic burden.

(1a) **Oxygen concentration.** As the total oxygen concentration in the feed gas is increased, concentration of hydrogen peroxide in the product stream increases but gross yield and the hydrogen peroxide:aldehyde ratio in the product decline. This aspect is not a serious consideration, however, as long as the feed ratio is held within the optimum limits outlined above.

(1b) **Hydrocarbon concentration** should not be less than 70 percent and higher content in the feed gas is desirable. Practical effect of this requirement is that the oxidizing medium must be either pure oxygen or, at least, oxygen-enriched air.

(2) **Presence of impurities.** Feed gas should be free of dusts. Among organic impurities, particular objection applies to unsaturated hydrocarbons which have a harmful effect on the reaction and will lead to excessive formation of oxygenated organic by-products. Harris[14] states that the unsaturated hydrocarbon content of the total reactor feed must not exceed 2 percent.

Since olefins are a by-product of the desired reaction (Equation 7), it is necessary to provide for their removal from recycle gas.

(3) **Diluents.** Most likely diluents, nitrogen and water vapor, are without harmful effect. In fact, Cook[13] states that the presence of small amount of water vapor improves hydrogen peroxide yield. However, such diluents impose an increased burden on the recovery and purification systems. Their maximum concentration is, of course, fixed by the considerations of hydrocarbon concentration and feed gas ratio, which are discussed above.

(4) **Pressure.** Cook[13] finds that *partial* pressures of the hydrocarbon and oxygen should, for the highest hydrogen peroxide yields, not exceed one to three atmospheres absolute. In general, the preferred operating pressure is essentially atmospheric.

(5) **Temperature.** At the lower temperatures, production of aldehydes (particularly formaldehyde) far exceeds hydrogen peroxide production. As the temperature is boosted, aldehyde formation declines rapidly and hydrogen peroxide yield rises to a maximum value. These trends are illustrated for n-butane in Fig. 2.[14] Here, the feed consisted of 95 vol percent hydrocarbon and 5 percent oxygen. Space velocity was 1620 hr.$^{-1}$

An extension of the curve above 495 C would show a very rapid drop in hydrogen peroxide content.

Exact level of optimum temperature depends on other variables. For different hydrocarbons, best conversion temperature decreases in the order ethane, propane, n-butane, isobutane. It is also decreased somewhat as the hydrocarbon: oxygen feed ratio is lowered and as reaction time is increased.

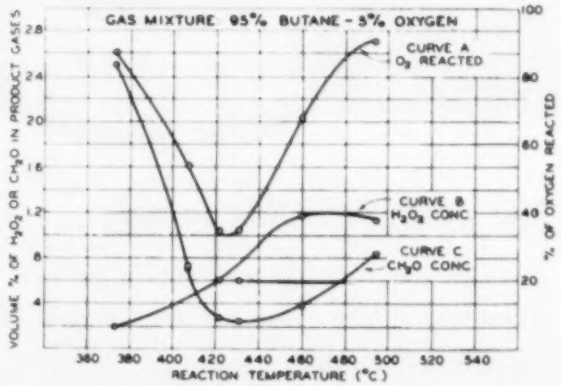

FIG. 1. The effect of temperature on the partial oxidation of N-Butane.

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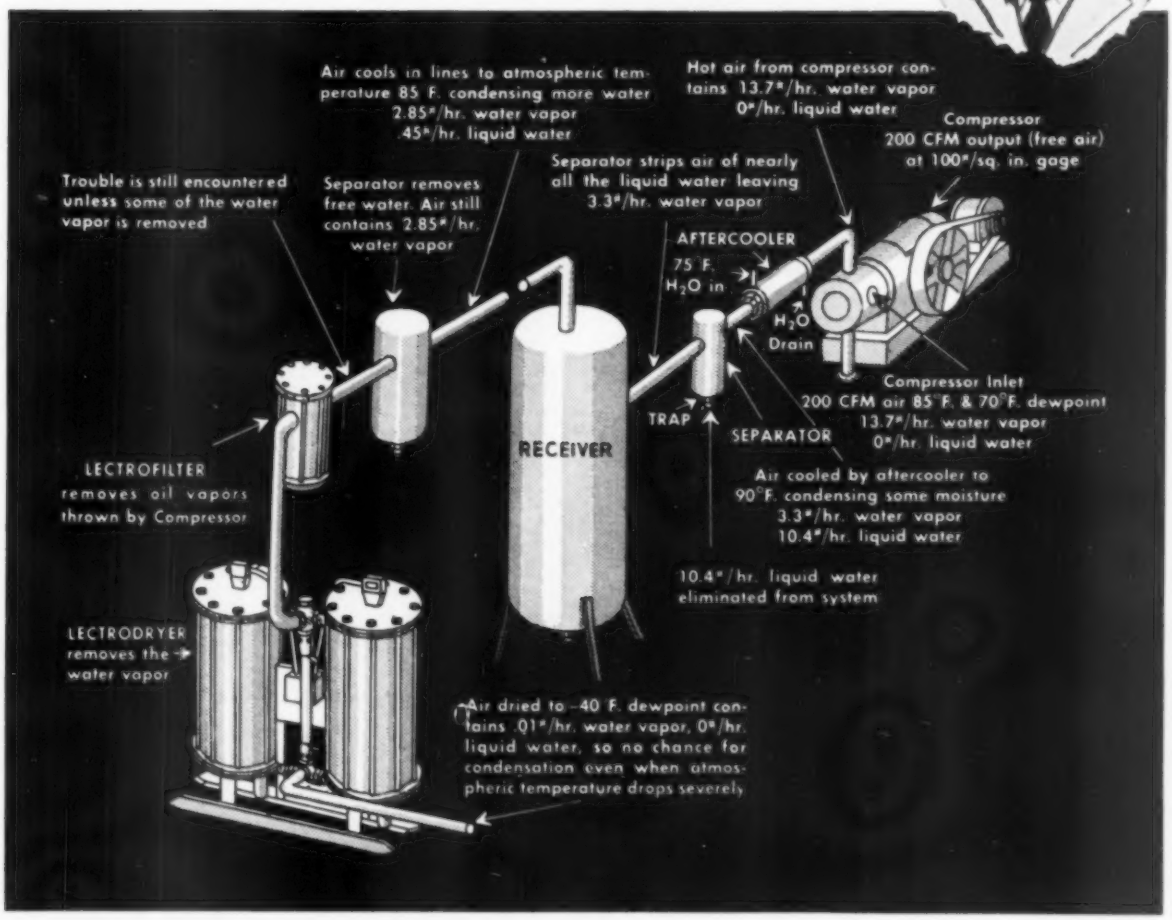
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Separator strips air of nearly all the liquid water leaving
3.3#/hr. water vapor
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H_2O in
H_2O
Drain
Compressor Inlet
200 CFM air 85°F. & 70°F. dewpoint
13.7#/hr. water vapor
0#/hr. liquid water
TRAP
SEPARATOR
RECEIVER
LECTROFILTER
removes oil vapors
thrown by Compressor
Air cooled by aftercooler to
90°F. condensing some moisture
3.3#/hr. water vapor
10.4#/hr. liquid water
10.4#/hr. liquid water
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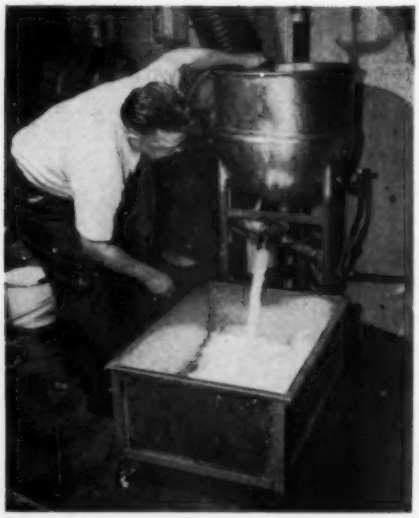

FIG. 2. One step for bleaching pulp with peroxide, shown here in laboratory equipment.
— Courtesy Solvay Process Division.

Effect of temperature on hydrogen peroxide yield must be viewed in the light of its effect on *oxygen conversion*. Interrelation between temperature and oxygen conversion is also shown in Fig. 1. Only 60 to 90 percent of the initial oxygen should be converted for highest concentration of hydrogen peroxide in the product. (Lower conversion gives somewhat better overall yield, but is not justified in the light of the greatly increased requirements on reaction space and recovery equipment.) In the system underlying Fig. 1, best conversion is at 65 to 70 percent of initial oxygen.

Because of the unfavorable effect of low temperature on product yield and by-product formation, Harris[14] recommends that the reactants be preheated separately to a temperature within the range favoring hydrogen peroxide formation, before they enter the reaction chamber.

(6) **Contact time — space velocity.** This variable influences yield of hydrogen peroxide, though it does so to a less significant extent than temperature. Best reaction time is affected by other variables of the system. It decreases with increasing molecular weight of hydrocarbon and with increasing temperature (or pressure). A workable range for n-butane is 1 to 6 seconds at actual reaction conditions. In the case of propane feed, Lacomble[16] recommends a range of 3 to 10 seconds, and a preferred contact time of 5 seconds (at 470 C).

(7) **Contact surfaces.** Nature of surfaces (e.g., walls of reaction chamber) in contact with the reaction phase exerts significant influence on performance. Oxidizable metals (iron, steel, copper, etc.) promote hydrogen peroxide decomposition and they are therefore not suitable as construction materials. Corrosion-resistant alloys (18/8 stainless steel, Monel metal) have a much less detrimental though still detectable effect. In using such alloys, Lacomble[16] tries to overcome this difficulty by cooling the reactor walls to 200 C so that reaction can occur only in central gas phase (at 450 to 500 C) — out of contact with the metal surfaces.

Pyrex glass, enamels, and smooth ceramic materials are entirely suitable as wall linings, at least from the point of view of reaction efficiency. Cook[15] claims that hydrogen peroxide yield may be improved by having contact surfaces of these materials pretreated with boric acid or certain borates. He claims further that reactor tubes, exceeding about two inches in diameter, should have some packing. It is quite possible that such packing will provide needed surface to break the combustion chain which would ultimately lead to formation of water and oxides of carbon at the expense of the desired product.

(8) **Aftercooling.** Immediately upon leaving the reactor, the make-gases must be cooled in order to prevent further degradation reactions. Quenching is possible but indirect heat exchange is feasible and yields a more concentrated crude product. Hydrogen peroxide is condensed as aqueous solution. Organic materials which will also condense, lead to degradation of hydrogen peroxide in the liquid phase. This tendency is especially pronounced in concentrated solution in which the presence of organic materials actually creates an explosion hazard.

There are two ways to circumvent this problem; First, it is possible to minimize condensation of organic compounds from the reactor gases by operating the aftercooler at 40 C. However, such dephlegmation action fails to recover all of the hydrogen peroxide and it does not avoid the condensation of organic materials completely. The alternate approach calls for injection of water into the reactor gases so that the condensate from the aftercooler will be diluted to the point where hydrogen peroxide degradation by organic compounds present is very slow.

In a process using propane as starting material, the following composition of dilute crude liquor from the aftercooler may be considered typical:[23]

	Percent
H_2O_2	3 - 5
Organic acids, chiefly C_1 to C_3 fatty acids	0.1 - 0.4
Alcohols, chiefly methanol	1 - 2
Aldehydes, chiefly C_1 to C_3 saturated aldehydes	1 - 4
Water	remainder

C. Hydrogen Peroxide from Aliphatic Alcohols

More easily controlled than the direct oxidation of hydrocarbons is the partial combustion of secondary alcohols to yield hydrogen peroxide and ketones (primary alcohols may be similarly oxidized to H_2O_2 and aldehydes, but in substantially lower yield). For the case of isopropyl alcohol, the following main equation applies:

$$CH_3-CH(OH)-CH_3 \xrightarrow{(O_2)} CH_3-\overset{\overset{O}{\|}}{C}-CH_3 + H_2O_2 \qquad (8)$$

There are two basic approaches to this reaction. The first, carried out in the liquid phase, is generally believed to be the course selected at Shell Chemical Company's Norco installation. The alternate vapor-phase oxidation has not, so far, attained commercial stature.

(1) **Liquid-phase oxidation.** Like other peroxide-forming reactions in the liquid phase (e.g., the commercially important autoxidation of cumene), the liquid-phase oxidation of isopropanol is carried out without outside catalyst. Hydrogen peroxide itself serves as reaction initiator, and it is added to the reaction system in order to avoid a lengthy incubation period. Peroxide added for this purpose is a 30 to 50 percent aqueous solution. While an amount as small as 0.005 percent by weight on the alcohol is able to start the reaction, normal hydrogen peroxide addition for initiation purposes is of the order of 0.5 to 1.0 weight percent.

Underlying the commercial process for liquid-phase oxidation of isopropanol to hydrogen peroxide and acetone is a method covered by N. V. de Bataafsche Petroleum Maatschapij.[24] This process calls for the use of 80 to 95 percent oxygen as oxidizing agent (oxygen of higher purity is technically feasible but too costly: Leaner gas is not as effective).

Conversion is carried out at 90 to 140 C. At lower temperature, conversion rate is unsatisfactory, while higher temperature results in decreased yield of hydrogen peroxide, probably due to degradation reactions. Operating pressure must, above all, be above the boiling pressure of isopropanol at reaction temperature. Actually, however, even higher pressure is called for since the conversion rate is increased with

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the partial pressure of oxygen in the system. For practical purposes, the pressure is held between 200 and 300 psig, i.e., just below the point where ASME code requirements call for more costly construction of pressure equipment.

As is the case in other hydrogen peroxide-forming processes, the material of reactor construction is critical. None may be selected which promotes the decomposition of hydrogen peroxide, as will iron, steel, nickel, etc. Good experience is reported for silicious materials, aluminum, tin, and organic resins. Furthermore, it is desirable to employ a reactor which has a relatively large ratio of volume to surface.

The process may be carried out in batch or continuous manner. Actually, better results are obtained in continuous operation. In this mode of operation, alcohol and oxygen are fed to a cylindrical, flooded reactor. Feed rate and product withdrawal are adjusted to maintain a steady state in the reactor. A wide range of hydrogen peroxide concentration in the alcohol is feasible at such conditions. Most likely content is 15 to 25 wt percent on the alcohol at the reactor outlet.

Alcohol is fed to the reactor together with some hydrogen peroxide (say 0.5 percent). Water content in the system should not exceed 20 percent, but concentration will probably not exceed the content of the isopropane-water azeotrope.

The reaction product must be water-diluted before distillative concentration to avoid an explosive condition due to the simultaneous presence of highly concentrated hydrogen peroxide and organic compounds. Also added at this stage are stabilizers such as sodium metastannate and acetanilide. Recovery and purification of the product takes the course outlined below.

As first step in the recovery process, acetone and unconverted isopropyl alcohol are distilled off. Typical of residual product is the following composition:[23]

	Percent
Hydrogen peroxide	6 - 10
Alcohols	trace - 2
Aldehydes	trace - 0.1
Ketones	0.1 - 2
Water	Remainder

This illustrates one of the outstanding characteristics of the liquid-phase process: Obtainment of a crude product which requires minimum purification. This observation is, of course, merely another way of stating that hydrogen peroxide and acetone are formed in very high yield, as percent of theory.

Thus, in one series of experiments, carried out at a per-pass conversion of 15 percent of alcohol, reactor yield of acetone was 93 percent on alcohol; hydrogen peroxide was obtained at 90 percent on oxygen consumed. Including purification, overall yield of hydrogen peroxide was 87 percent on isopropyl alcohol.

(2) **Vapor-phase oxidation.** This version of the isopropanol oxidation to hydrogen peroxide is also carried out noncatalytically. Operating variables follow a pattern similar to that noted above for the oxidation of lower aliphatic hydrocarbons to hydrogen peroxide.

Air, as such, or enriched with oxygen serves as oxidizing medium. In the case of oxidation by air, the alcohol:oxygen feed ratio is about 5:1 but this ratio must be raised for enriched air and is about 10:1 if pure oxygen is used.

Overall feasible temperature range for the reaction is 350 to 500 C. But for a given set of conditions (feed alcohol, reactants ratio, contact time) an optimum temperature exists which must be controlled within narrow limits.

As in hydrocarbon oxidation described above, not more than 90 percent of the initial oxygen may be converted per pass; best performance is in the 60 to 80 percent range. At higher conversions, by-product formation becomes excessive. At a given temperature, the extent of conversion is controlled by contact time which ranges from 0.5 to 1.0 seconds (calculated at NTP).

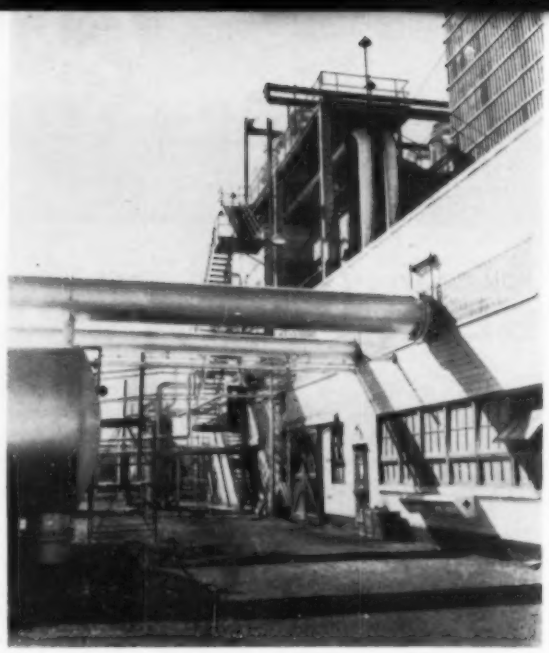

FIG. 3. All-weather design makes for better control, easier maintenance. — Courtesy Solvay Process Division.

What has been said above about the selection of materials of construction for the reactor in hydrocarbon combustion, applies equally to the oxidation of alcohols for hydrogen peroxide formation. Harris[17] states that acidic enamels, e.g., fused coatings of boric acid, are especially suitable. Use of cooled reactor walls made of stainless steel has been proposed for this alcohol oxidation also.

The reactor make is quickly cooled to a temperature below 100 C. Further cooling will yield a crude aqueous hydrogen peroxide solution, containing also unconverted alcohol, co-product ketone, and various other oxygenated organic compounds formed in side reactions. Solution strength depends on the amount of water fed to the reaction system with reactant alcohol, but should not exceed 40 to 50 percent hydrogen peroxide to prevent an explosion hazard (in the presence of organic materials). Here, as in hydrocarbon oxidation processes, there is advantage in further dilution by water injection at the aftercooler stage.

Crude liquor is fractionated for overhead removal of an alcohol-water azeotrope (which is recycled), co-product ketone, and other light boilers. Bottoms from this stage are taken to hydrogen peroxide purification following methods to be outlined below.

Conditions for a specific case of isopropanol oxidation to acetone plus hydrogen peroxide have been stated by Harris.[17] Feed consists of 50 vol percent air, 33.5 percent isopropyl alcohol, and 16.5 percent water vapor (i.e., the composition of the water-isopropanol azeotrope).

Mixture is fed continuously to a reaction chamber in which the maximum temperature is held at 450 to 460 C. Contact time (calculated at NTP) is 30 seconds.

At these conditions, about 50 percent of the feed oxygen is reacted and 80 percent of this is converted to hydrogen peroxide. Product is cooled; water is added to the condensate at the rate of 0.1 lb per lb alcohol fed to the reactor. Residual alcohol, and 16.5 percent water vapor (i.e., the composition tion on charcoal.

The liquid product is stripped at 100 mm Hg abs., leaving a 25 to 30 percent aqueous H_2O_2 solution. Recovered isopropyl alcohol-water azeotrope is recycled to the reactor stage.

At these conditions, overall yield is reported at 0.7 moles hydrogen peroxide and 0.9 moles acetone per mole isopropyl alcohol consumed.

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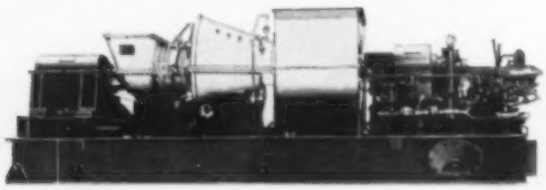

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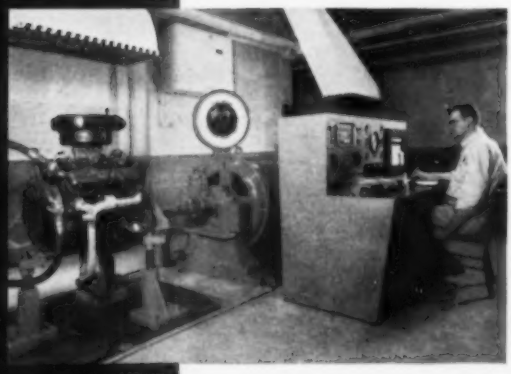

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FIG. 4. Loading Hydrogen Peroxide in railroad tank cars at the Syracuse, N. Y. plant of Solvay Process Division.

D. Concentration and Purification of Hydrogen Peroxide

The bulk of hydrogen peroxide is sold as aqueous solution of 35 wt percent or 50 percent strength. A small amount of production (from the barium process) is shipped as 8 percent solution to nearby consumers for bleaching purposes. 90 percent hydrogen peroxide was first offered in the United States in 1946. During the latter part of 1955, Becco Chemical Division of Food Machinery & Chemical announced the commercial development of hydrogen peroxide at nearly 100 percent strength. Foreseeable markets for this grade are principally in the military field.

Fractional distillation serves to upgrade the crude liquors from hydrogen peroxide synthesis to the standard commercial strengths of 35 and 50 wt percent. The atmospheric boiling point of pure hydrogen peroxide is 150.2 C and the system H_2O — H_2O_2 exhibits a high relative volability over almost its entire range. From this point of view, therefore, distillative concentration offers no real problem.

There are some special problems, however. As the concentration of hydrogen peroxide as well as of contained impurities increases above 40 percent, the solution becomes increasingly unstable. Prior purification (see below) may therefore be required. Furthermore, rate of hydrogen peroxide decomposition increases with temperature. In the vapor phase, contact with certain metals and metal oxides may lead to explosions.

In the production of 35 percent hydrogen peroxide, these difficulties are overcome (a) by distillation under vacuum (100 — 300 mm Hg); (b) choice of inert materials of construction (e.g., aluminum); and (c) addition of a small amount of stabilizer, such as sodium stannate.

A commercial process for the production of 80 to 85 percent hydrogen peroxide by vacuum (40 mm Hg abs.) rectification has been described.[18] Special mention should be made of the use of a high-nickel stainless steel for the steam coils in the reboiler, in order to avoid formation of a decomposition catalyst. The use of tantalum in this application has also been mentioned.

The feed to the rectifier column is flashed. This leaves a liquid phase in which the organic components (derived, in this instance from the 2-ethyl anthraquinone process) are accumulated. H_2O_2 content of this phase is 70 to 75 percent. This liquor must eventually be discarded or else diluted to the point where it is innocuous, for sale as off-grade product. H_2O_2 recovery was about 85 percent.

There is explosion hazard inherent in the presence of large pools of concentrated hydrogen peroxide containing organic material. To avoid this, various proposals (e.g.,[19]) have been put forth for the use of climbing film evaporators to flash the crude hydrogen peroxide solution fed to the rectification system.

To reach H_2O_2 concentrations above 90 percent by distillative methods is not feasible. The approach is defeated by the need for excessively high vacuum to hold vapor temperature below the point of hydrogen peroxide decomposition. Becco Chemical Division's process for production of H_2O_2 at 97+ percent concentration is reported[20] to be based on fractional crystallization for the final upgrading.

Underlying is a method due to Crewson.[21] Feed is 90 percent hydrogen peroxide. This is cooled to −20 C to form a mixed solid-liquid phase. Hydrogen peroxide concentration of the solid phase is 93.2 percent and that of the liquid phase is 82.5 percent. The solid is allowed to settle through a heated vertical tube in which a temperature gradient is carefully established, ranging from −20 C at the top to −3 C at the bottom.

In effect, this provides numerous equilibrium stages between solid and liquid. Liquid is withdrawn at the top in 82.5 percent strength. Bottom mash is withdrawn in 97.8 hydrogen peroxide concentration (the solid phase contains 99.3 percent H_2O_2).

Purification. Crude reaction liquors fed to the concentration (i.e., distillation) stage contain, in some instances, heavy metal contaminants in concentration exceeding the limits permissible for marketability. For removal of these impurities, Young[22] proposes the use of ion exchange resins of the sulfonated polyvinyl aromatics type (e.g., sulfonated polystyrene-divinyl benzene resins). Resin must be pre-treated by washing with acid solution (e.g., 10 percent sulfuric acid). The pH of the solution to be treated is held below 3.6 (note that the pH of commercial hydrogen peroxide solutions is between 2.0 and 4.5). Treatment is claimed to remove iron, lead, copper, manganese, and hydrogen peroxide from the liquor and to enhance the stability of the product in storage.

Dunlop[23] recommends a chemical method to free dilute hydrogen peroxide solutions of organic contaminants. Hydrogen peroxide is reacted with lime in the presence of a small amount of sodium pyrophosphate to precipitate calcium peroxide. Following filtration and thorough washing of the solid, the calcium peroxide is reconverted to hydrogen peroxide by pressure treatment with carbon dioxide, again using sodium pyrophosphate as catalyst. Following filtration, the resulting dilute hydrogen peroxide solution is treated with ion exchange resin (as defined above) for the removal of residual calcium and iron introduced with the lime. The method is intended for use preceding the distillative cencentration step.

Bibliography

1. *Chem. Week*, March 3, 1956, p. 72 ff.
2. Solvay Hydrogen Peroxide (a brochure published by Solvay Process Division, 1956).
3. *Chem. Eng.*, August 1954, p. 304.
4. Satterfield, C. N. *Chem. & Eng. News* 32, 2726 ff. (July 5, 1954).
5. Schumb, W. C. et al., "Hydrogen Peroxide." New York, N. Y. (1955).
6. Anon. *Chem. & Eng. News* 45, 5388 (November 5, 1956).
7. Sherwood, P. W. *Pet. Ref.* January 1953, p. 97 ff.
8. Sherwood, P. W. *Pet. Ref.* March 1953, p. 113 et seq.
9. *Chem. Week*, April 14, 1956, p. 96.
10. Dawsey, L. H. et al., U. S. 2, 537, 655 to Buffalo Electro-Chemical Company, Inc. January 9, 1951.
11. Sprauer, J. W., U. S. 2, 673, 140 to E. I. duPont de Nemours and Company. March 23, 1954.
12. Corey, A. E. and Harris, R. C., U. S. 2, 739, 042 to Allied Chemical & Dye Corporation. March 20, 1956.
13. Sprauer, J. W. and Williams, T. V., U. S. 2, 739, 875 to E. I. duPont de Nemours and Company. March 27, 1956.
14. Harris, C. R., U. S. 2, 533, 581 to E. I. duPont de Nemours & Company. December 12, 1950.
15. Cook, G. H., U. S. 2, 416, 156 to Linde Air Products Company. February 18, 1947.
16. Lacomblé, A. E., U. S. 2, 376, 257 to Shell Development Company. May 15, 1945.
17. Harris, C. R., U. S 2, 479, 111 to E. I. duPont de Nemours & Company. August 16, 1949.
18. Slater, V. W., et al. CIOS Report No. XXXI — 15.
19. Wood, W. S., et al., U. S. 2, 520, 870 to Laporte Chemicals, Ltd. August 29, 1950.
20. *Chem. & Eng. News*. December 12, 1955, p. 5422.
21. Crewson, G. G. et al., U. S. 2, 724, 640 to Food Machinery & Chemical Corporation. November 22, 1955.
22. Young, J. H., U. S. 2, 676, 923 to E. I. duPont de Nemours & Company. April 27, 1954.
23. Dunlop, A. K., et al., U. S. 2, 695, 217 to Shell Development Company. November 23, 1954.
24. N. V. de Bataafsche Petroleum Maatschapj. Brit. Pat. 708,339. May 5, 1954.

★ ★ ★

DU PONT *Petroleum Chemicals* NEWS

Number 80 in a Series of Bulletins for the Petroleum Industry

OCTOBER 1957

Du Pont FOA-2 provides advantages to refiners as well as to their customers

"BRIEF CASE" PRESENTATION WELL RECEIVED BY PETROLEUM INDUSTRY AND ITS CUSTOMERS

The "Brief Case for Business" presentation was announced in a NEWS ad last January. Since then 500 kits have been put to use, and they are expected to play an important role in this year's Oil Progress Week. Developed by the Du Pont Petroleum Chemicals Division, the "Brief Case" tells an oil industry public relations story in much the same way as the popular "Magic Barrel" has been doing so successfully for nearly five years.

The "Brief Case" presentation, introduced last January 1st, is sponsored by the Oil Information Committee of the API. It tells in a highly dramatic way the importance to the American economy of oil products and of products made from oil. According to OIC estimates, over 1,000 presentations will have been made by November 1 – to club, school and civic groups throughout the country.

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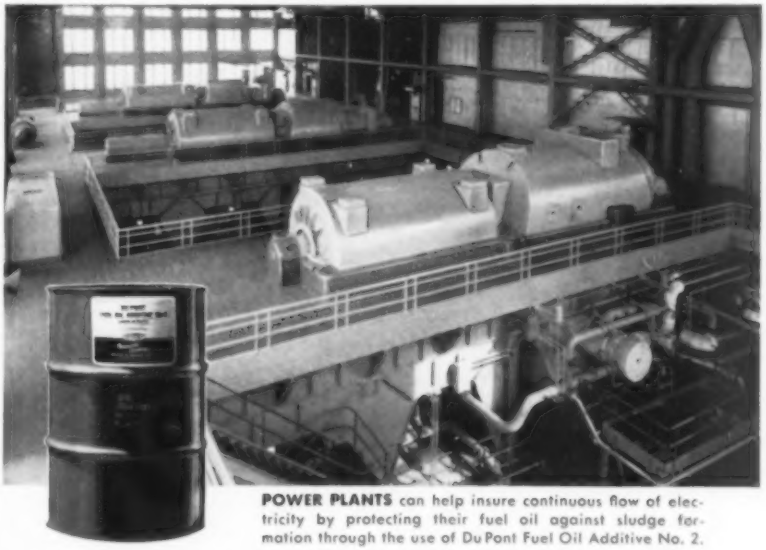

POWER PLANTS can help insure continuous flow of electricity by protecting their fuel oil against sludge formation through the use of Du Pont Fuel Oil Additive No. 2.

FOA-2 makes it possible to blend catalytic-cracked stocks with straight-run products and still maintain good storage stability and performance. Because of this, refiners can adjust their inventories of heating and diesel fuels to meet varying seasonal demands. And the storage stability of a catalytic-cracked stock by itself can be increased by the addition of FOA-2.

The additive also helps to upgrade stocks to increase the yield of domestic heating oils, and release straight-run stocks for charging stock.

Protects wide range of products

The stabilizing and dispersant action of Du Pont FOA-2 is highly effective across the whole range of distillate fuel oils. This means that the same additive that retards and disperses sludge formations in home heating oils can be used to help prevent injector-sticking and filter-clogging in all types of diesel fuel – for truck, tractor, marine, industrial, and railway locomotive engines.

With this extremely broad range of usefulness, many refiners are able to realize substantial savings in their overall manufacturing and distribution operations through the use of this single additive.

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Because of the nature of the product, sludge problems with residual fuels can be particularly troublesome. Many of the problems can be readily solved by periodic treatment of the system with FOA-2. But it's even easier to prevent them and eliminate many costly tank-cleaning operations by simply adding a small amount of FOA-2 to the residual fuel before it goes into the storage tank.

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OVER

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CONTINUED

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A new combination "package" of DuPont Fuel Oil Additive No. 2 premixed with DuPont Metal Deactivator has been offered to refiners during recent months.

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JOHN D. ROGERS is supervisor of the jet and aviation fuels research group at the DuPont Petroleum Laboratory, Carney's Point, New Jersey. In this capacity he serves as an aircraft engineering consultant, working closely with the engine manufacturers and Navy and Air Force test centers on evaluation of fuel performance in the latest aircraft. And his staff at the laboratory analyzes trends in military requirements and related commercial developments to help refiners meet present and future demands for aviation petroleum products.

His broad experience has ideally equipped him to provide refiners with competent aid in these fields.

He joined the DuPont Company in 1951 as a senior engineer at the Petroleum Laboratory. He did engine and combustion research on fuels, and worked with refiners on automotive performance studies until 1954. Before coming to DuPont, he did development work on rocket and jet aviation fuels for a major oil company. During World War II, he was with an aeronautical corporation as combustion analyst and design engineer on B-29 engines.

Mr. Rogers received his B.S. degree in mechanical engineering at the University of Delaware. Later he was an instructor at Yale University, specializing in internal combustion engines. He has also a master's degree from Stevens Institute of Technology, and did advanced study of thermodynamics and fluid mechanics at the University of California in Berkeley.

He is a member of the Institute of Aeronautical Sciences, American Rocket Society and the Society of Automotive Engineers. He is active on the Aviation Fuels Technical Committee of the ASTM and the Aviation Fuels Division of the Coordinating Research Council.

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OVER

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PART 2 | **Automation in Refinery Product Blending**— *accurate control of petroleum products additives flow is paramount; overdosage can throw products off-specification and increase costs needlessly. Described here is the equipment that can be used for proper proportioning*

ADDITIVE METHODS IN CONTINUOUS BLENDING

Lawrence Lowy
Proportioneers, Inc.

LAST month we introduced the reader to the concept of automatic blending and some of the tools that could be applied to measure large volume flow rates. But, any consideration of conversion from batch mix to in-line continuous blending must take into account the increasingly important additive feeds, too.

Here we are not dealing with large flow rates, but rather quantities measured in 1 and 2 percent or even a fraction of a percent of total blend rate.

Often, these additives are critical to production of a particular specification. Or they are so costly that any overfeed represents a considerable unnecessary expense. Then too, hazards to health such as with TEL, are more likely to be encountered.

Increasing emphasis is given to additives and the particular quantities that they can impart to a motor fuel, a lube oil, an asphalt cutback, etc. Usually, quantities are so small and critical as to defy the crude measurement previously employed in batch systems. This lends added impetus to inline blending methods where quantities, no matter how small, can be fed accurately and dependably. And for those so critical and/or costly as to require more than ordinary care, extremely precise methods are available using weight as the medium of measurement.

Where batch blending or compounding is carried out, minute addition of additive may be carefully measured out in a separate container or, for accuracy, preweighted. For larger quantities volumetric meters equipped with set stop mechanism can be utilized. In this case an operator sets a totalizer mechanism for total volume. As the quantity is fed through the meter it runs the totalizer in reverse till it registers "0" at which point it trips a release to close a valve in the line. All of these arrangements are susceptible to human error. To compensate for this, an excess is usually injected. But additives are costly, so that at the end of a year's operation, the value of additive overfeed can represent a large expenditure just to be "sure."

Continuous blending can materially reduce this cost, if not eliminate it entirely. In addition, it can incorporate safeguards to monitor any trends where too little or too much additive will ruin a batch or require that it be doctored.

Types of Injection Equipment: Plunger Pumps

Injection or feeding of the additive for continuous flow operations must be carried on by repeatable, dependable units. The first of these, and probably the one most often used, is the positive displacement plunger pump. One might feel that any small capacity, positive displacement plunger pump would suffice. However, unless carefully calibrated and checked from time to time, the usual rotary — be it gear, lobe, vane, etc. — is extremely susceptible to viscosity and pressure conditions and resulting slip characteristics (the

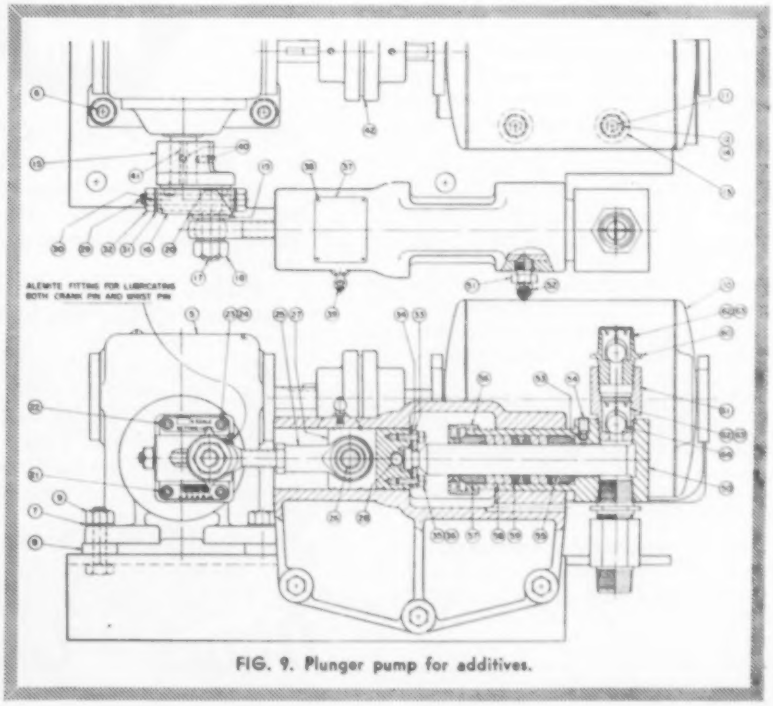

FIG. 9. Plunger pump for additives.

clearances which will allow varying quantities to pass due to viscosity variations). This is most critical at low flows where the slip can be a significant percentage of total flow. On the other hand, a plunger pump, Fig. 9, reflects slip only through the check valve assembly. Slow movement of the piston in reciprocation as compared to rapid rotary input into the other positive displacement type pumps means too that check valve movement is slowed, an aid in allowing tight seating and reduction of slip. As a result, this type of unit lends itself economically and accurately to injection of small quantities — a fraction of a cc per min to 2 gal per min.

The pump packer (Fig. 9) consists of a motor (10) driving an integral gear head or separate speed reducer (5) whose output shaft normally drives a crank (15). A crank arm (25) — through the crosshead — converts this rotary motion to reciprocating movement of a reagent plunger (55).

A threaded crank allows manual adjustment of the crank arm distance relative to its rotary center. This can be varied from zero to maximum throw, which in turn will provide stroke-length settings of the plunger — producing a delivery range from zero to maximum capacity. The crank is calibrated to indicate this setting. Normally these pumps are guaranteed within plus or minus 1 percent accuracy for a 10:1 delivery range.

In the reagent or additive cylinder, as a precision-ground plunger is withdrawing the preset stroke length through a stuffing box, a metered volume of solution is drawn through the suction line. With plunger motion reversed, the suction valve closes (valves are normally of the ball type) and the volume is forced through the discharge check valve to the point of application.

Since the pump is of the reciprocating type, a pulsating flow will occur — in this system, discharge flow occurs during the alternating suction period. This effect can be reduced or almost eliminated by use of multiple pumps mounted on a common base-plate, with discharge strokes exactly out of step. Hydraulic dampers or surge chambers may also be used.

Units of this type can be furnished in special metals, rubber, plastic or ceramic — thereby making them suitable for handling any chemical. To accommodate a pacing signal from a primary source, the capacity can be automatically adjusted by varying drive motor output (example — electronic variable speed drive between motor and pump) or repositioning crank arm relative to crank (example — pneumatic positioner capable of reversing threaded crank screw).

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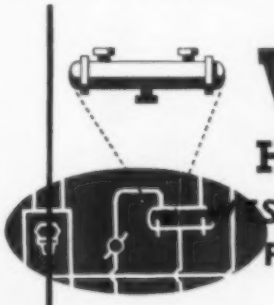

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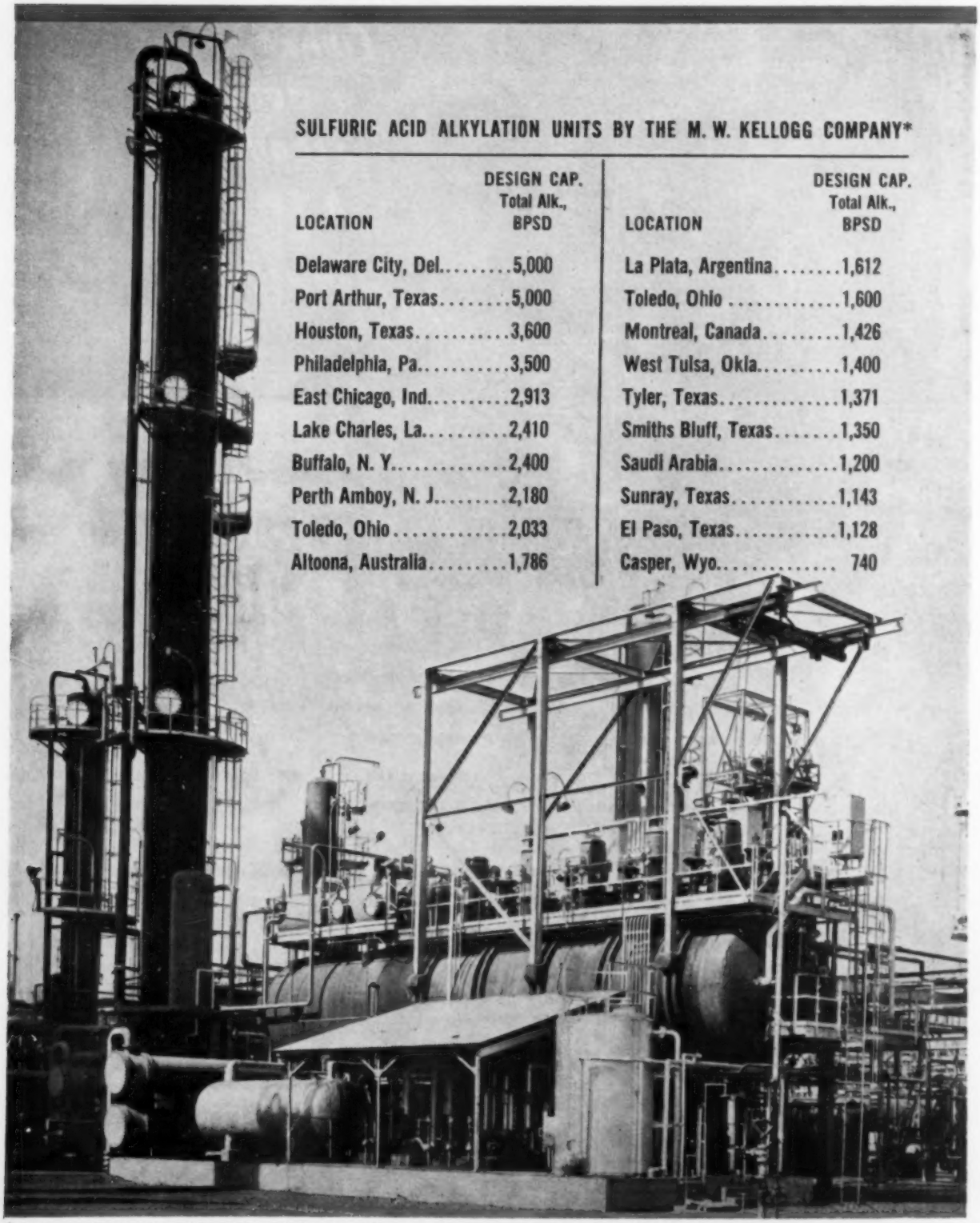

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Perth Amboy, N. J.	2,180
Toledo, Ohio	2,033
Altoona, Australia	1,786
La Plata, Argentina	1,612
Toledo, Ohio	1,600
Montreal, Canada	1,426
West Tulsa, Okla.	1,400
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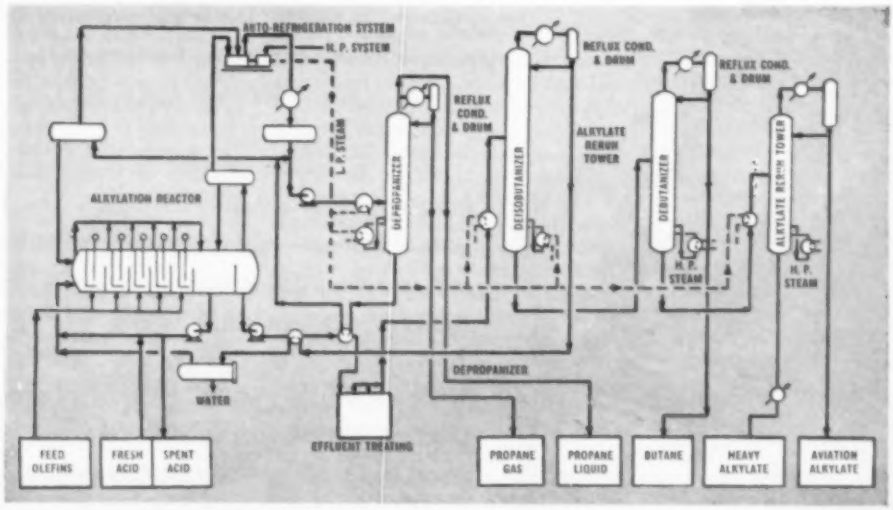

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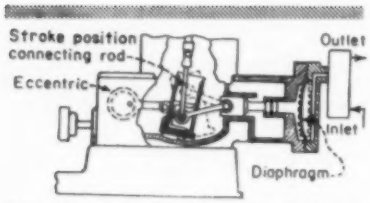


FIG. 10. Positive displacement diaphragm pump.

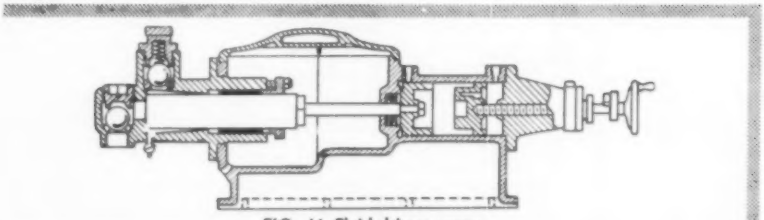


FIG. 11. Fluid-driven pump.

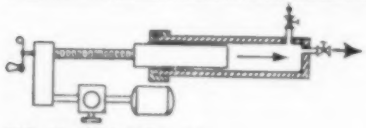


FIG. 12. "Syringe" pump.

Diaphragm Pump

Instead of a solid plunger, the fluid motivating force can be applied by a diaphragm, actuated either by a plunger or hydraulic fluid as shown in Fig. 10. The advantage in this type of positive displacement unit is the elimination of packing. The diaphragm acts as a gasket, too, tightly sealing the reagent cylinder. The diaphragms are normally Neoprene or rubber, but in recent installations, special materials such as plastics and metal alloys have been used effectively.

Fluid-Driven Pump

A modification of the motor operated positive displacement pumps described above is the pneumatic or hydraulic-powered metering pump (Fig. 12). This can be either a positive displacement plunger or diaphragm unit — but instead of motor and crank, pneumatic or hydraulic powering furnishes the drive.

The reagent plunger is operated by direct connection to this pneumatic or hydraulic drive. Stroking is produced by action of a pilot valve, normally paced from a primary source (example — a positive displacement meter rotation is translated into reciprocating motion to drive valve in proportion to flow) but often in response to some other process variable. Piston movement is limited by the position of a rear adjustable stop, and can be set for zero to maximum stroke length by means of the micrometer threaded shaft running from the piston to the handwheel. A counter geared to this shaft reads stroke length in increments of 0.01 in.

Capacity settings are made by reference to delivery curve furnished with each unit. Since delivery is represented by a straight line function, stroke setting for desired output can easily be read and set by handwheel positioning of stop. Smooth cushioning of the piston at the end of each stroke is provided by means of fixed and floating dash pots having adjustable bleeder ports.

Differences in Units

Both the crank-driven metering pump and the fluid-operated unit have seen described. A basic difference exists between these two.

The clearance volume (that space still remaining in the reagent cylinder with the plunger fully forward in the completed discharge position) is extremely important in metering pumps. It determines if the pump will be self-priming, i.e., relieve itself of entrained air when discharging against pressure.

Ratio of total displacement volume to clearance volume will vary in the crank-driven unit as stroke length changes are made, but it will remain constant in the pneumatic type. Ratio for the motor crank pump will be high for maximum stroke (minimum clearance). When the ratio drops below an easily computed value ($P_1 V_1 = P_2 V_2$) the pump will not purge itself of air.

In the pneumatic unit, since stroke length is controlled by limiting the rearward motion of the plunger, the ratio of displacement to clearance volume will not change for different settings.

The motor-driven unit will not reproduce capacity settings at low speeds, because of such factors as fluid viscosity and check-valve efficiency (slip). A hydraulic unit will be unaffected by extremely slow speeds, because each stroke is made at the same speed regardless of frequency. At high stroking rates consideration must be given to fluid viscosity, as sufficient time must be allowed on the suction stroke for the cylinder to fill before discharge is begun.

The "Syringe" Pump

For small, high-accuracy feeding a modification of the reciprocating positive displacement plunger is available (Fig. 12). This type might better be characterized as a syringe, for it operates exactly like the familiar hypodermic syringe.

A plunger within a cylinder is retracted, and fluid to be metered fills the chamber. The suction is then closed off and the discharge opened. A geared-down drive, with suitable range adjustment, slowly moves the piston forward at a constant rate. Feed is in terms of cc per hour, and cylinder capacities are designed for four or more hours operation before plunger retraction and refill is required. Units can be dual mounted for continuous operation (while one fills, the other feeds).

Application and Control

Application of these positive displacement pumps to specific injection jobs ranges from constant feed units manually set for rate on through to incorporation into full blending packages.

For flow proportional operation, various schemes are available. Again, because flow constitutes the largest source for primary or pacing signal in blending operations, we continue to refer our discussion to it. Other types of measured variable can be used — pH, viscosity, gravity, color, etc. — in much the same manner as described for flow. Where the pacing signal comes from a differential meter (refer to Part 1) it may be used in the form of an on-off signal (using time duration impulse) to operate a 3-way valve in the pump suction, Fig. 13, or as a proportional signal — 3 to 15 psig air — to adjust output of a variable speed drive unit, Fig. 14.

If instead, the primary pacing element is a positive displacement meter we can use the rotary spindle output (X gallons per spindle revolution) as a direct translation of flow. This can be used, Fig. 15, to stroke a pilot valve, which, in turn, will alternately time drive air to the front and rear ports of the impulse cylinder on a pneumatic style pump.

Rather than directly drive a pilot, the rotary signal can be delivered as an electric pulse or contact (each revolution of the meter produces 1 pulse). The pulses can register against preset counts in a timer. When the proper number have accumulated, a second timer, preset for timed operation of the

Methods of controlling additive flow rates . . .

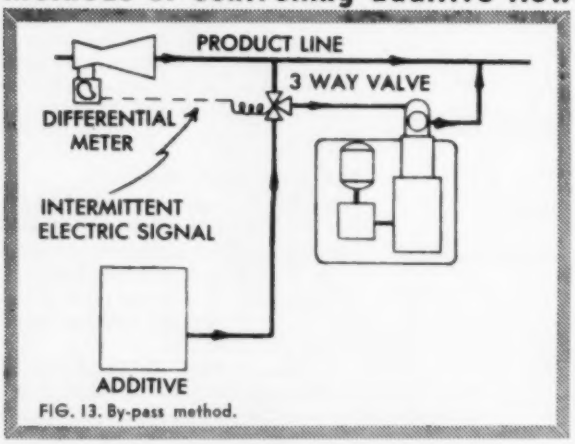


FIG. 13. By-pass method.

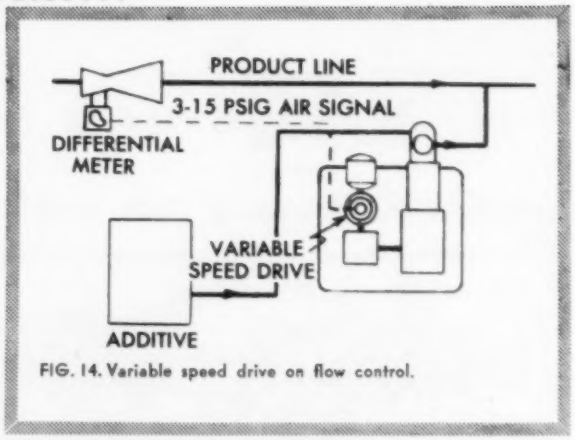


FIG. 14. Variable speed drive on flow control.

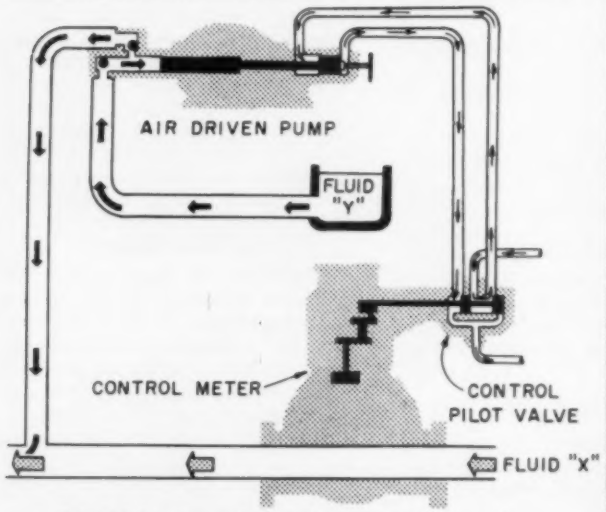


FIG. 15. Pilot-valve controlled, air-powered additive system.

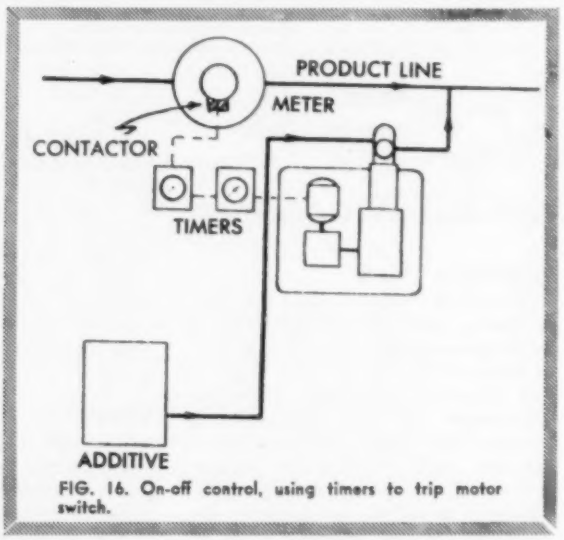


FIG. 16. On-off control, using timers to trip motor switch.

pump, will control the duration of additive injection, stop the pump, preset and await the next accumulator signal to again feed for the preset duration (Fig. 16).

Instead of accumulating as a timer signal, the pulses can be used to operate a clutch on the plunger pump between motor to pump. Each pulse produces one stroke and the tendency to override or stroke again is arrested by a stop brought into play immediately after the initial clutch release (Fig. 17).

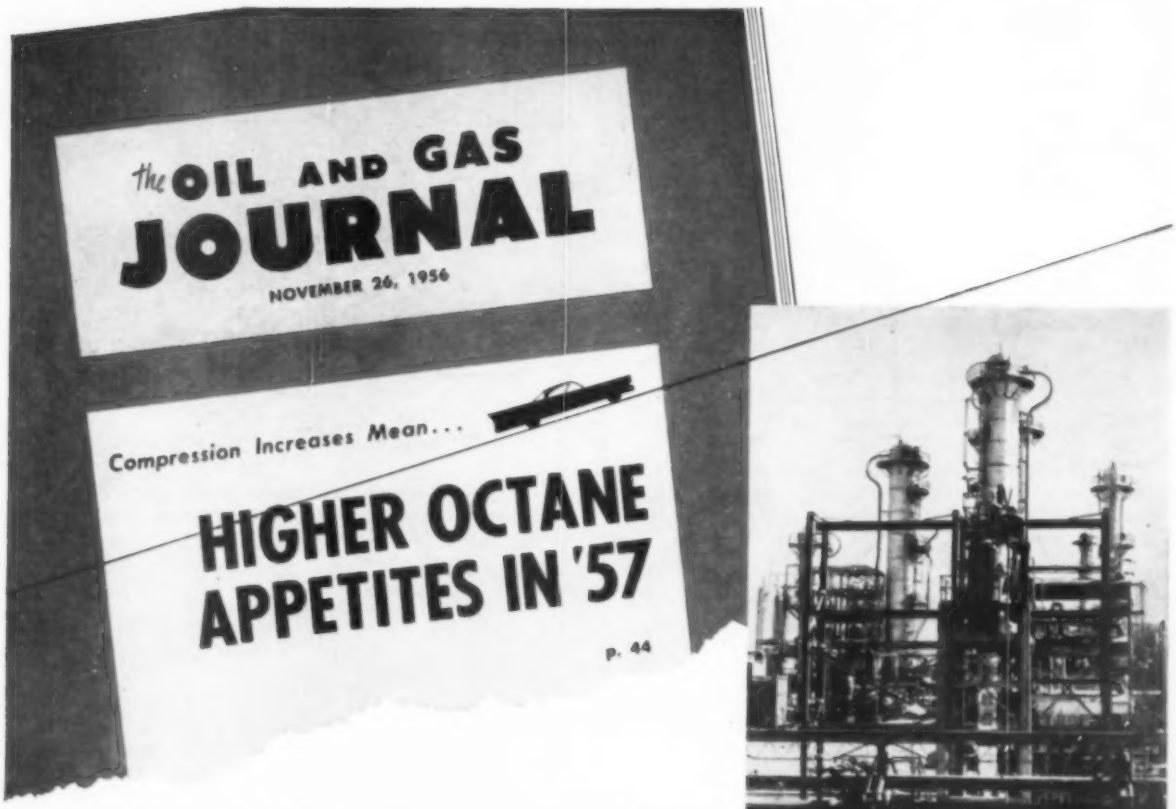
Feedback or Loop Control

In all of these system using positive displacement pumps, one important factor is ignored. The first article in this series discussed considerations for in-line blending. One of the concepts most strongly stressed was that of the closed loop or feedback. In describing a feeder device of the pump type, we have neglected this consideration and usually the fact is accepted – for a positive displacement plunger pump, over set, it will dependably deliver at rate.

No matter how accurate a device may seem to be truly dependable we must have report-back on what it is doing. The pump style just described does not provide this. Additions can be made to approach a check, but they are of an intermittent type. For example, a calibration tank (small capacity slender take with accurate gage glass) can be inserted between supply tank and pump. At any time during a run, the additive can be drawn from this tank and accurately read over a period of time. This is a partial answer. Pumps of this type are very susceptible to air bubbles — packing leaks, supply tanks running dry, air entrainment. Consequently, while a calibration check may show all is well, an air bubble shortly thereafter may remain unpurged and throw off all of the following discharge volumes until it is caught.

Another solution might be a positive displacement meter in the pump discharge. This has several drawbacks. For one, capacities below 0.25 gal per min in this type of meter, are not sufficiently accurate and repeatable. Then, too, unless sufficiently dampened with surge chambers, the pulsation from the pump tends to alternately run the meter too fast, then too slow. This is not good for the meter nor is it conducive to accurate readings.

Where rates of additive feed exceed 0.25 gal per min a closed loop scheme is available. It is very similar to that described for large volume flows in last month's article. As seen in Fig. 18, the pulse signal from a contactor on a main line positive displacement meter is again used (this could be a pulse from any source). Because this scheme is particularly suitable for remote operation, we have shown the transmission by electrical pulse. Direct connection would duplicate the large volume schemes previously referred to. A converter translates the pulsed signal into a mechanical rotary output to be matched to the mechanical rotary output delivered by the additive meter (capacities above 0.25 gal per min). Suitable fixed gearing provides the necessary ratio or, for wide ranges or ratio adjustment, an input speed adjusting device can be included. Should a difference exist between the input speed from the master and the follower or ad-



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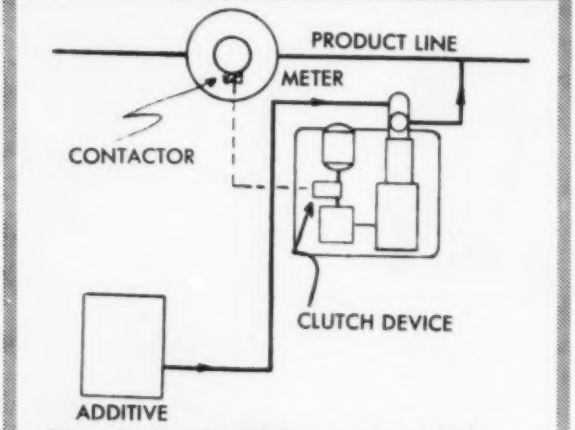


FIG. 17. On-off control, with timer engaging a clutch.

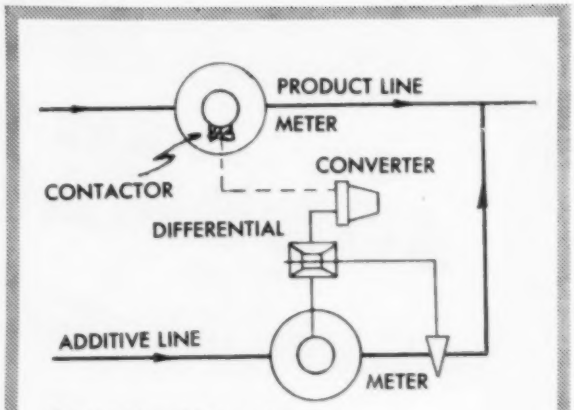


FIG. 18. Differential flow rate control.

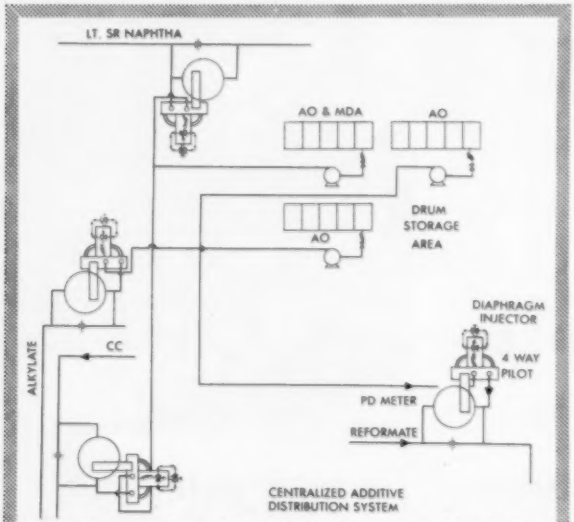


FIG. 19. Centralized additive distribution system, with additive on flow control.

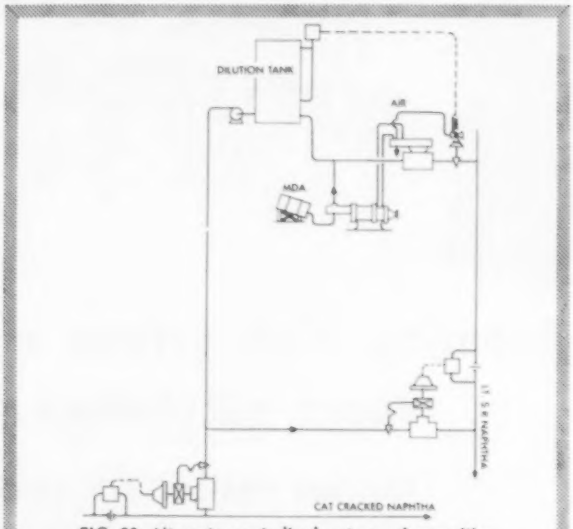


FIG. 20. Alternate, centralized system, using positive displacement pumps.

ditive meter, the differential gear riding the two opposite rotating gears will be displaced. In moving either direction of control it directly (sufficient power in the differential eliminates the need for servos) repositions a control valve in the additive line to bring the follower meter rate back up or down to match the required master rate.

Another arrangement would utilize the flow rate control scheme also discussed in the previous article. However, instead of a manual set point, a primary source such as a 3-15 psig air signal for flow will adjust this point through a suitable ratio presetting. In additive feeding, a rotameter is used instead of the orifice or differential device due to its suitability for the low flows encountered.

Centralized Additive Systems

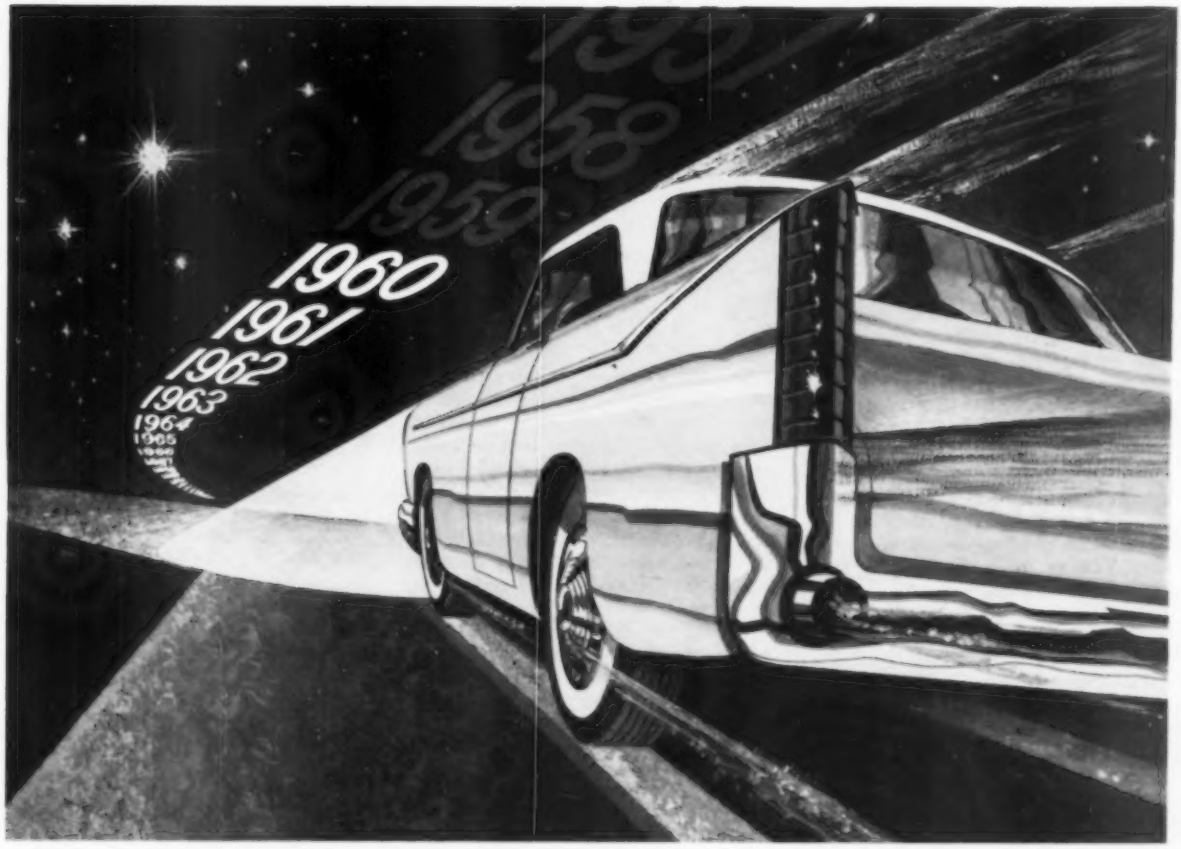
The devices thus far described for additive injection service are aimed at ultimate incorporation in blending schemes. However, there is an area in which their use alone is a matter of concern as points of additive application increase around the refinery process area. Too often, "pots and pans" are scattered all over a process plot to provide inhibitor at 4 or 5 locations for instance, each one having its own supply and injector.

Since we are discussing additive feed devices and methods, let's review a method to eliminate the "pots and pans" effect of gasoline additive facilities. By this means, a centralized location for the various additives can be provided with individual injection facilities at the necessary locations at the time when new construction takes place or at any future time without the cluttered, makeshift arrangements so prevalent as today's refinery needs expand.

In Fig. 19, the drum storage area is designated. This can be at any location remote from the actual injection points. Additive feed lines are then run from this area to the necessary pipeline points of injection. Within the drum storage area the various additives, as received in drums, can be separately stored on drum racks. By means of flexible connection, each successive drum can be designed as a gravity feed system making the connect and disconnect operation simple for the operator and capable of being handled by a single man.

Each of the additives, i.e., metal deactivator, inhibitor, upper cylinder lubricant, etc., will be tied into an individual centrifugal pump utilized merely for transfer purposes. Suitable electrical interlocks can control operation of these pumps so that when any one of the particular additives is required, the necessary supply pump system will be energized. The pumps furnish only the transfer and pressurizing features for the system.

A simple injector device will be lo-



New Du Pont study looks into octane requirements of the future

A new Du Pont study points up the complexity of the problems you may face in planning future refinery processes and operations. Solution of these problems may depend on the answers to two basic questions:

What road octane quality can be expected from possible future gasoline compositions in tomorrow's high-compression-ratio cars?

Which of the gasolines of comparable road octane quality will be most economical to make?

Recently, some answers to the first question were found by Du Pont researchers investigating gasoline blends suitable for tomorrow's cars. More than 5,000 road octane numbers were obtained during the Du Pont study.

High-compression-ratio cars used in test

Twenty-eight representative samples from the five major refining processes in 73 different fuel blends—at 10 pounds RVP and leaded to 3 ml. per gallon—were road-rated in a fleet of cars whose engines were modified to 11.1 and 12.1 compression ratios.

With the data provided, cost comparisons can be made between blends of comparable octane quality to answer the question of maximum refining economy.

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Several conclusions were reached on the basis of information gathered during the Du Pont study. The complete results are now available in a paper entitled, "Road Octane Numbers of Tomorrow's Gasolines in Tomorrow's Cars." Write us if you would like a copy.

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cated at each of the points of application. It is assumed that some sort of orifice or differential device for metering purposes will be located at this point in each of the gasoline component lines. By installing a small bypass loop around this and installing a small positive displacement meter, a flow-proportional signal can be obtained which will in turn produce a mechanical rotary movement. This will operate a 4-way pilot valve located in the additive line coming from the drum storage area. Movement of the pilot valve controls flow of additive into either side of a diaphragm cylinder connected across the 4-way valve. The other two ports serve to receive the additive from storage area and inject it into the line under pressure. The actual feed ratio will be manually adjusted at each of the injector stations by limiting the travel of the diaphragm in either direction. Two or three sizes can be furnished to accommodate the entire range of additive requirements.

The injector device and positive displacement can be developed as a single package and readily transferred from operation to operation or added as expansion requirements dictate. Electrical interlocks can be utilized where certain lines will receive additive only part of the time. This can be readily controlled from a central station.

An alternate scheme can also be proposed. The previous arrangement is developed on the theory that the most economical way in which additives can be injected and handled is to minimize the actual materials handling. The major problem to date is the dilution of additive in hydrocarbon in order to produce quantities sufficient for proportioning purposes. The method above handles the material neatly, with sufficient accuracy to meet most refinery requirements.

Centralized Positive Displacement Pumps

Another approach is to dilute the additive sufficiently so that it can be handled by means of positive displacement pumps or meters. The latter scheme is preferred as it provides ready adaptability to the closed loop or feedback principle.

For this arrangement it is necessary to dilute the additive to a degree that will produce a minimum of ⅓ gal per min for any job conditions. The drum storage area referred to above would now become a tank storage area in which, for example, 4000 gal capacity tanks would be utilized to make up the necessary solution before metering it to the required gasoline line.

Automatic means can be provided to make up the solution when necessary. See Fig. 20. Low level switches in the tanks would actuate electrical controls. This could be done by energizing a positive displacement meter in the diluent line. The meter would in turn actuate a secondary feed device to inject additive directly from drum storage. This is illustrated in Fig. 16. When the fill had again reached a preset high level it would automatically cutoff until needed again. In this way an endless supply of well diluted additive is available.

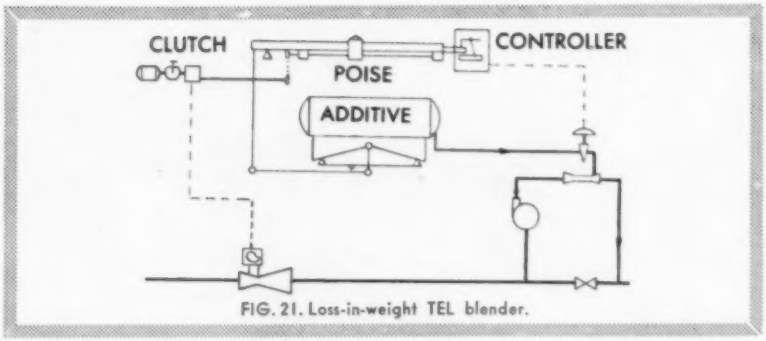

FIG. 21. Loss-in-weight TEL blender.

Again, at each of the necessary points of injection a device would be located to meter and feed the necessary quantity of additive into the flowing stream. In this case, however, since the quantity is of a sufficient magnitude, a positive displacement meter is used much as is illustrated and described in Fig. 19. Instead of a mechanical rotary signal developing a pulse or electric contact signal, a converter device can be installed on the differential meter to develop the differential pressure as a pulse generator transmitting to the EDB Blender. The blender itself is composed of a converter to develop a mechanical rotary action proportional to the pulse signal. This drives one side of a geared differential device. The additive meter drives the other side and any deviation of metered rate from master rate as established by main line flow will actuate control valve in additive stream to bring the metered additive rate in line with master.

Loss-in-Weight System

Thus far the discussion has concerned only volumetric devices. Such measurements are susceptible to effects of temperature, viscosity, gravity. To avoid either realizing these and correcting for them or ignoring them and accepting the resulting errors, the alternative is to measure and dispense by weight. With large volumes encountered in blending base stocks, the cost to use a gravimetric or weight feed system is not justified and suitable adjustment is made to volumetric reading to compensate for the aforementioned errors. But for additives representing, as they do, items of considerable cost, the savings from overfeeding by the less accurate volumetric scheme would soon cover the cost differential. This is particularly true in the case of tetraethyl lead. Needless to say, though, the increasing use of additives at relatively high cost is becoming more and more of a problem. Not only are the feed requirements low, but often they must be maintained within close limits to produce the desired characteristics. This leads to increased doctoring of batches or losses due to slop. Should the tolerances be broadened, the losses from overfeed represent a large expenditure over a year's operation. Losses also mount up from double handling — drum to vessel to mix tank (one of the basic factors justifying automation is its reduction of materials handling).

Where extreme accuracy is desirable — high additive cost, close tolerances or minute quantities — the gravimetric device is most suitable. In Fig. 21 a typical TEL system is shown schematically.

Here, because of the relatively high cost of the material, it is essential to hold within close tolerances. Otherwise the normal overfeed condition would be the mode of operating in order to be "sure." A few pounds overfeed of TEL per batch represents a large expenditure in a year's operation. By feeding gravimetrically (thereby maintaining very tight limits unaffected by temperature) and providing in line feed with positive shut-off, this loss can be eliminated. While this application is the only gravimetric application in production of petroleum products, the system has ready application to other additives now on the horizon presenting the same sort of economy considerations. Of course, the TEL application presents another problem — toxicity. To minimize the hazard, TEL is handled under vacuum so that should a leak develop, the air will be drawn in and TEL will not escape.

In this case a tank of 8500 or 15,500 gal capacity is scale mounted. This represents a complete tank car delivery which eliminates any primary storage problem and reduces handling of this very toxic fluid. An additional feature of this particular application is that any conveying of TEL must be done under vacuum.

The tank is scale supported by means of one first class lever and two second class levers connected to a precision scale head providing accuracies of 1 lb in 10,000 lb. A flow signal from a Venturi Tube in the gasoline line is transmitted either as an intermittent electric signal of 0 to 13.3 sec every 15 sec or a pneumatic pressure of 3 to 15 psig to the scale head to drive a finely threaded poise screw to pace poise retraction in proportion to the gasoline flow.

The TEL rate, somewhere between 0 and 3 cc per gal of gasoline, is set into a roller type variable speed device or integrator. This drives, from a synchronous motor source, directly through a clutch and chain and sprocket connection to the poise retracting screw. The flow signal actuates the clutch in the case of the intermittent electric signal. The system operates on a null balance principle requiring the scale to maintain balance at all times. As the poise travels back along the screw it reduces the scale beam load indicating a TEL demand. A linkage at the tip of the scale beam senses this deviation from the null balance position and alters the air output from an air controller operating on the "nozzle flapper" principle to correct or reverse this movement. This air signal goes to the control device, a diaphragm motor valve with streamlined plug, and, in the case of a lead demand, increases air on the valve to open it wider and allow more lead into the line. Actually the sensing and response is so rapid that an extremely smooth movement takes place when flow varies. Should the valve allow too much TEL in proportion to gasoline flow, a reverse action takes place. The poise now lags the scale demand and as a result the beam will drop causing the air controller to decrease the pressure on the valve and cause it to throttle. In every case as soon as the upset is corrected the valve assumes a new balance position correct for altered flow conditions.

The equipment in actual operation has provided a finished product having an accuracy of plus or minus 0.03 cc (by chemical analysis) TEL per gal of gasoline for dosages of 0.5 to 3 cc per gal.

As previously mentioned, TEL addition is always handled by weight. Other additives, metered in this way, can also produce desirable results in such form as savings in excess feed, closer limits on specification, etc.

In subsequent articles the various measuring elements and blending concept will be tied into packages as they apply to fuel oil and asphalt blending, lube oil production and motor fuel, avgas and jet fuel blending. ★ ★ ★

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FIG. 1. The plug valves take up little more space than the pipe diameter. They may be installed in any position, just so the stems are accessible. Here, an operator adjusts a 3-in. valve on a line carrying mineral oil to a compounding tank.

Valving Critical in Elaborate Distribution System

Herbert W. Boyd
Assistant Plant Engineer
E. F. Houghton & Company

THE ELABORATE distribution system at E. F. Houghton & Company's Philadelphia plant has been likened to a plumber's dream. A leading maker of industrial lubricants, metal and textile oils, special chemicals and mechanical packings, Houghton has found multiple piping circuits a necessity in moving a variety of liquid raw materials and products.

Potentially, a multiple piping system can be a source of trouble. Leakage and inflexibility can add materially to overhead costs. However, Houghton's attention to system planning has assured a flexible and economic distribution system. Two of the most important considerations have been the use of pipe segments with flexible connections and use of lubricated plug valves to control the system.

Use of pipe segments has allowed any area of the plant to be connected easily to any other area. And the valving system—using over 3000 lubricated plug valves, 1½ to 4 in. in size—has saved an estimated $15 to $20 per valve per year considering initial cost, installation, and maintenance.

The need for multiple pipe circuits involves the nature of Houghton's processes. In the case of industrial lubricants, for example, Houghton manufactures scores of different grades. This requires mineral oils of many different viscosities as raw materials. Separate circuits must be available for distributing each mineral oil to the correct tank for compounding. And more lines must be available for transferring each industrial lubricant product to a drum loading area. Similar situations occur with other processes.

The segmented rows of pipe constitute the crux of the distribution system. With the aid of flexible metallic or Neoprene hose, pipe segments may be interconnected. If a continuous piping system were used, cut-offs, tee's, take-offs, and headers would be required and flexibility of distribution would suffer. More pipe would probably be necessary.

With the present distribution setup, almost any area of the plant may be connected via piping with any other area. This is necessary because of the wide variety of raw materials and products; a certain raw material used in one process may also be required in another process, for example. Or, a product of one process may be required as a raw material in another process.

Typical Piping Layout

A typical layout of pipe segments occurs in the distribution of certain mineral oils. One segment originates in the basement. Here, 90-gal-per-min pumps are available for diverting mineral oils from storage or tank cars to any one of 15 plant locations simply by hooking flexible hose between desired lines.

From the basement, the segment proceeds to the third floor. Another "interchange" point occurs here; flexible hose is used to divert the oil to any of several compounding tanks.

After compounding, another pipe segment carries product to the drum-loading station on the first floor. At this point, the operator uses flexible hose to connect the drum-loading pump with any of about 30 product lines. Many pipe segments terminate here.

Valving Requirements

Approximately 1500 3-in., 700 1½-in., 600 2-in. and 200 4-in. lubricated plug valves constitute plant valving. These semi-steel valves are installed at interchanges and other points on lines carrying products, fatty acids, ethyl alcohol, caustic solutions, sulfuric acid, amines, hydrocarbon solvents, mineral oils, steam and water. To meet system requirements, valves had to conform to certain installation, operation and maintenance requirements.

From the installation standpoint, valves could not be bulky. Space is at a premium since rows of 8 or 10 pipes frequently occur in horizontal layers at interchange points. To conserve space pipe segments and interchanges are run close to ceilings and walls. Lubricated plug valves proved particularly suitable here, since they contain no projecting yokes or bonnets. In addition to savings in space, substantial weight savings were realized through the absence of cast bonnet and body cavities, flanges, etc., in this type of valve.

Operationally, valves are required to close quickly and easily. Fast action is desirable because of the large number of valves that must be quickly adjusted when interconnecting pipe segments at interchanges. The action must be easy to minimize operator fatigue. Positive closing and opening is a must, to avoid waste through leakage and to minimize possibilities of incorrect valve adjustment.

Lubricated plug valves have proved capable from all three operational standpoints. Fast action is obtained since a quarter turn of the valve is all that's required to open or close the valve. A stop collar on the valve clearly indicated plug position; the operator doesn't have to rely on "feel" to tell how far the valve is opened or closed.

Although used primarily for open-close operation, lubricated plug valves may also be used for throttling where accurate adjustment is not necessary. The valves can be used to throttle from full flow to drip.

Maintenance

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Direct-connects to remote pneumatic recorder or controller, such as Consotrol® panel recorder shown below.

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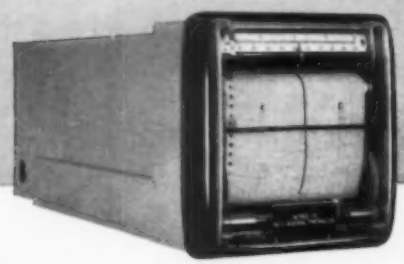

At last — a tachometer with 3-15 psi air signal *directly proportional* to rpm! Speed changes are recorded on a uniform-scale chart. Accurate measurements of rpm are easy to read throughout the entire range. No crowded bottom scale!

The Type 16A Speed Transmitter is available for ranges from 0-320 rpm to 0-5300 rpm. Full-scale accuracy of ±½% is consistently maintained. Small and light weight, it can be mounted *in any position* — never needs lubrication.

For rotating equipment having wide speed variations, the Type 16A is ideal. It can easily be incorporated into any present pneumatic control system. Write for full details.
The Foxboro Company, 6410 Neponset Avenue, Foxboro, Massachusetts, U.S.A.

FOXBORO
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PNEUMATIC SPEED TRANSMITTERS

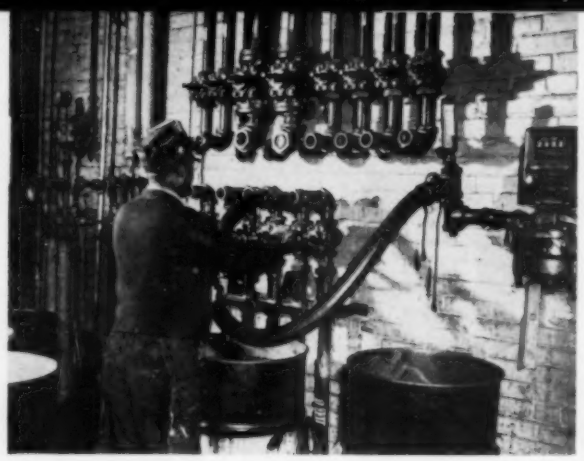


FIG. 2. At this interchange point an operator adjusts a 2-in. valve on a line carrying mineral oil to a compounding tank. Note the numbers on the lines that code the materials carried. The barrel is used for draining after the flexible hose has been disconnected.

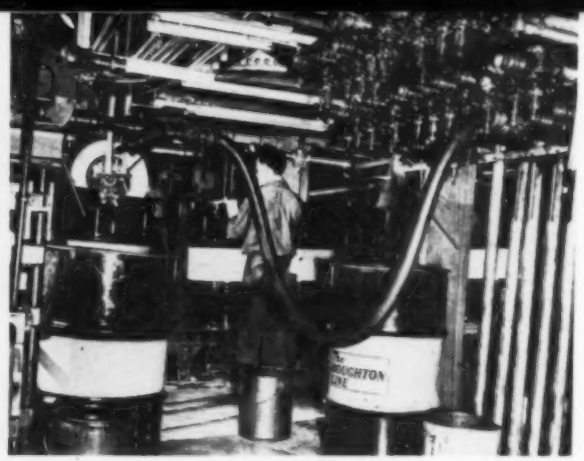


FIG. 3. Manifold system at the automatic drum-filling station. Flexible hose is used to connect desired product line with the filling pump. The scale in the left background cuts off the pump when the drum is full.

cation for the distribution system. Considering the over 3000 valves in the system, maintenance could be potentially a prize headache.

By using lubricated plug valves, savings on maintenance, initial cost and cost of installation have been estimated at $15 to $20 per valve per year. In certain instances these valves have outlasted other valves by more than five times. Some valves used previously on lines carrying corrosive materials had to be serviced once every three or four months; certain components, for example seat rings, wore out about that often. New seat rings cost money. And occupying a man for a half-day servicing four or five valves was expensive in terms of time.

Also, some valves had to be disconnected from the line to service them. If the valve was connected to the line through flanges, no great problem was encountered. For welded or threaded connections, however, lines were often cut to remove valves. After servicing the valves, more time was consumed reinstalling them. For threaded connections, if the line was cut the pipe had to be rethreaded. A nipple had to be cut and a union installed. Cost of a union: About $16 for a 3-in. and $22 for a 4-in.

Properly lubricated plug valves rarely require maintenance. On some lines, they haven't been removed in over 15 years.

The only service required is maintaining lubricant in the valve stem. This can be accomplished by a simple program of periodic lubrication while the valve is on the line.

New Method to Build Tank Foundations

A new system of building tank foundations is now being developed in a tank farm at Esso Standard Oil's Bayonne, New Jersey, refinery. Here's how it works: Mounds of sand and chrome-ore are being placed on unstable soil where 150,000-bbl tanks are slated to be built next year.

The mounds will stay in place 10 months and studies indicate that the sand and chrome-ore will compress the organic soil and enable the surface to stand the weight of the huge tanks.

This is the first time that any such foundation system has ever been used in an Esso unit. The normal procedure is to drive wooden piles where the soil is soft and erect the tanks on the piles. Known as "pre-loading," the new system is more economical and equally effective as previous uses indicate.

Best known usage of the pre-load foundation system is on the New Jersey Turnpike. When that artery was being constructed, mounds of fill were placed on top of the right of way through swamp lands and meadows where soil conditions indicated that unusual settlement might take place. The system worked very well.

Work on the building of the mounds — nearly 25 ft high at their peak — has just been completed. They will stand until early April 1958, when they will be removed and work begun on the tanks.

Settlement platforms, which are actually steel plates six feet in diameter, have been placed in the sites of the three tanks. Twenty-foot poles have been welded perpendicular to the plates and the mounds will be built around these poles.

The poles are being painted "candy stripe" fashion but this is not for decorative purposes. Measurement of the settlement of the platforms will be possible through the reference marks indicated by the stripes.

Other instruments will be used to measure the amount of water in the organic soil underneath the settlement platforms.

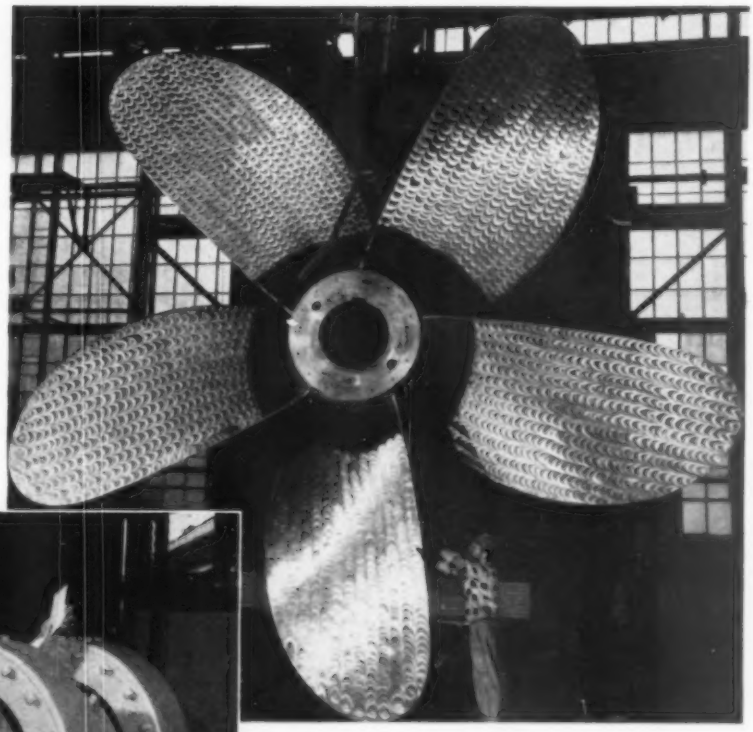
Mounds of sand and chrome-ore being erected on the sites of three tanks at Esso's Bayonne refinery. Now completed, the mounds are about 25 ft high and will be left for 10 months to "preload" the soil prior to erection of the 150,000-bbl tanks. Studies show that this method will compress the soil enough to support the tanks, thus eliminating costly piles.

BETHLEHEM MARINE EQUIPMENT

Super-Service for Super-Tankers

BETHLEHEM'S NICKEL-ALUMINUM BRONZE PROPELLERS have a life span up to *6 to 8 times longer* than comparable manganese bronze wheels. They are approximately *18 per cent lighter* in weight, and provide *greater propulsion efficiency* and fuel savings. Unusually rugged, with extreme resistance to erosion and corrosion, they *pay for themselves* in Super-Service.

The Nickel-Aluminum Bronze Propeller shown here was designed, cast and finished-machined by Bethlehem for a 46,000-dwt tanker. It has a diameter of 22 1/2 ft and finished weight of 67,200 lb.



▲ **BETHLEHEM'S UNIVERSAL CHOCK** protects expensive mooring lines from chafing or fraying during warping, mooring or towing operations. Ruggedly constructed of cast steel, it takes heavy radial loads through a rotating center member completely supported and accurately aligned on ball bearings. This center can turn 360° and keeps the mooring line in full contact with the rollers of the chock's riding sheave. Designed and constructed for *maximum service and minimum maintenance*, it's a boon to the cost-conscious ship operator.

**In Europe, Asia, Africa and Australasia, BETHLEHEM'S UNIVERSAL CHOCK is handled by Friedrich Kocks GMBH of Bremen, Germany, under an exclusive sales and manufacturing agreement.*

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Nickel-Aluminum Bronze,
Nickel-Manganese Bronze, Manganese Bronze,
Iron and Steel.

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Geared Turbine Propelling Machinery.
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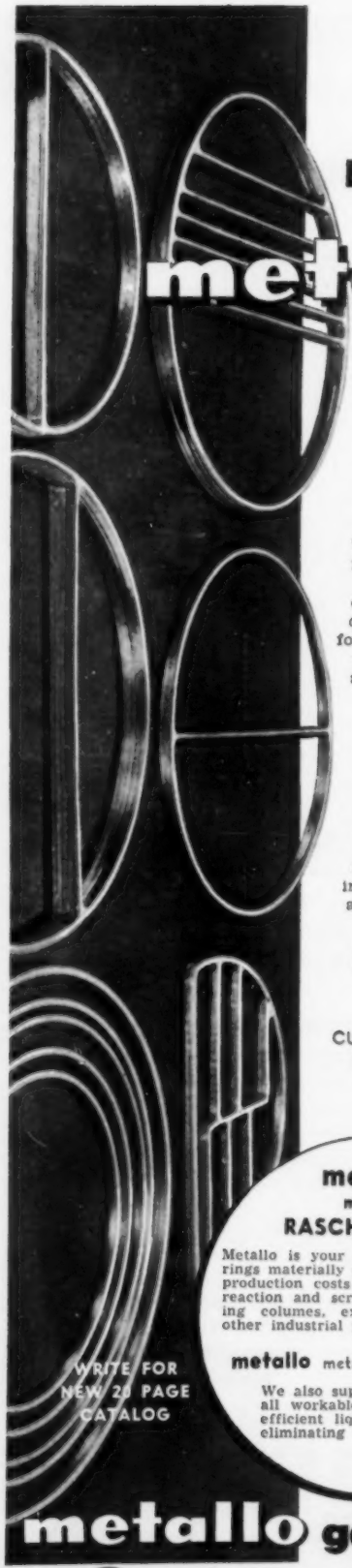

special gaskets for HEAT EXCHANGERS by metallo

Fabricated in special shapes to exact specifications. Under fatigue of severe operating conditions, they are superior in sealing efficiency, longevity and ability to retain physical and chemical properties. These gaskets are built for specific purposes in strict accordance with customers' requirements or templates. When used for recommended services, they completely satisfy and give extra long life. A group of specially constructed Metallo Gaskets are made for heat exchangers with metal jackets and asbestos filler. These gaskets, including irregular shaped gaskets for any process equipment, are readily made in several different styles and shapes, in any metal and in sizes limited only by transportation facilities. These gaskets are also cut from solid sheet metal.

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Metallo is your primary source. These rings materially decrease operating and production costs on a wide variety of reaction and scrubbing towers, rectifying columes, extraction systems and other industrial processes.

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Second Schoch Lecture Series Slated in Austin in October

Dr. D. L. Katz

E. P. Schoch

The second of the E. P. Schoch Lecture Series at University of Texas will be given by Dr. D. L. Katz, chairman of the Chemical Engineering Department, University of Michigan, in Austin on October 15 and 16. This series includes three lectures, to be given at 2:00 p.m. October 15, and at 2:00 and 8:00 p.m. October 16, in Batts Hall.

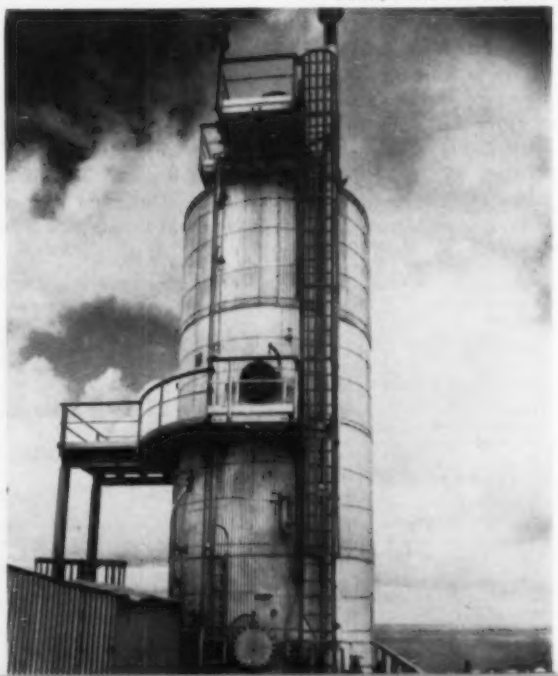
The subject will be "Phase Equilibria at Low and High Pressures," and will cover solid-liquid, vapor-solid, and vapor-liquid equilibria as well as more complex systems. Both fundamental and practical aspects will be presented. All interested persons are invited. These lectures are in honor of Dr. Schoch, famous retired physical chemist of the University staff. On October 16, he will be 86 years old. The first series was given by Dr. W. K. Lewis, in 1956 on "Recent Advances in Fluidization."

Aluminum-Coated Sheet Steel Durable Material for Weather Shields

A reformer reactor and a cracking unit catalyst disengager are two of seven high-temperature vessels in the Magnolia Petroleum Company refinery, Beaumont, Texas, protected by aluminized steel.

On the 13 ft 9 in. diameter, 90 ft high reactor, it shields the large metal vessel from driving winds and rain; also provides insulation by reflecting radiant heat. On the 14 by 30-ft catalyst disengager, located atop of a 230-ft high tower, aluminum-coated steel was used for the protective covering because of its combination of strength and corrosion resistance.

— Courtesy Armco Steel Corporation



Portable gas products plant

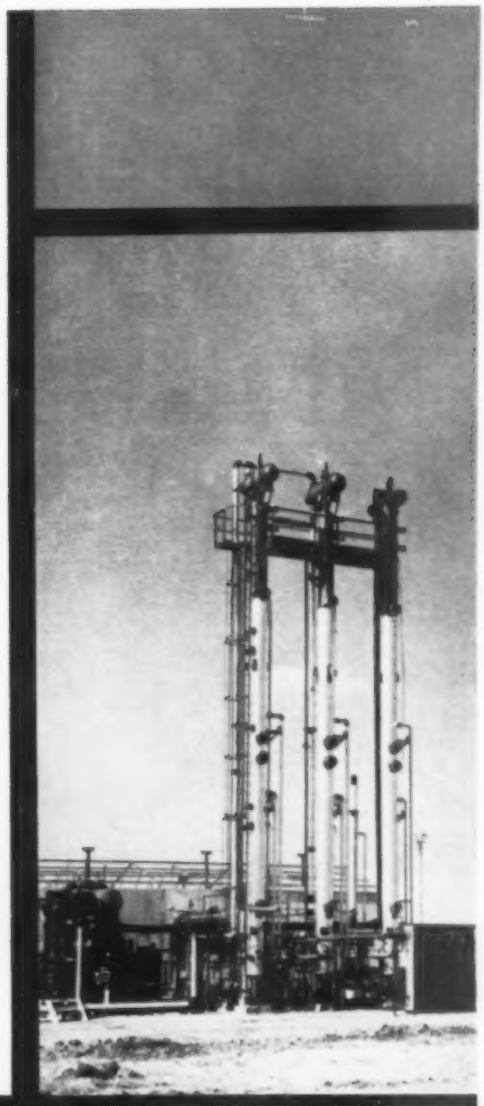
The McNamar Portable Gas Products Plant offers the operator the most economical means of producing Propane, Butane, Natural Gasoline or Stabilized LPG.

The plant pictured is an automatically operated straight refrigeration process and is skid-mounted to insure a low field installation cost.

Another prominent cost saving feature of the plant is it's complete portability . . . if moved to a new location, up to 85% of your original investment can be recovered.

McNamar plants are also designed on oil absorption and combination oil absorption and refrigeration processes. Designs are dependent upon overall economics and percent recoveries.

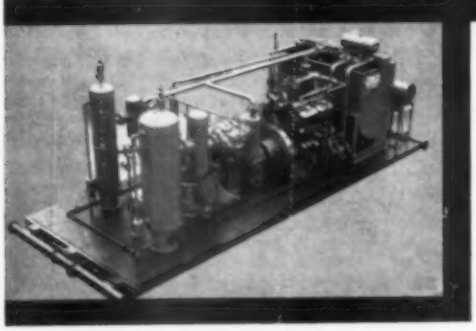
Call, write or wire Gas Products Division of McNamar Boiler and Tank Company for further information.



McNAMAR

Desulphurization Plants

Glycol and Solid Desiccant Dehydrators



Compactness, portability and versatility are symmetrically designed into the McNamar Joy WNB 112, 200 horsepower, twin cylinder Gas Compressor. The completely packaged units are easily installed and economical to operate.

The McNamar - Joy Gas Compressor units may be engineered to your application and are available on purchase, rental and rental-purchase option basis. 50, 100, 200 and 400 horsepower sizes are also available.

McNAMAR TULSA

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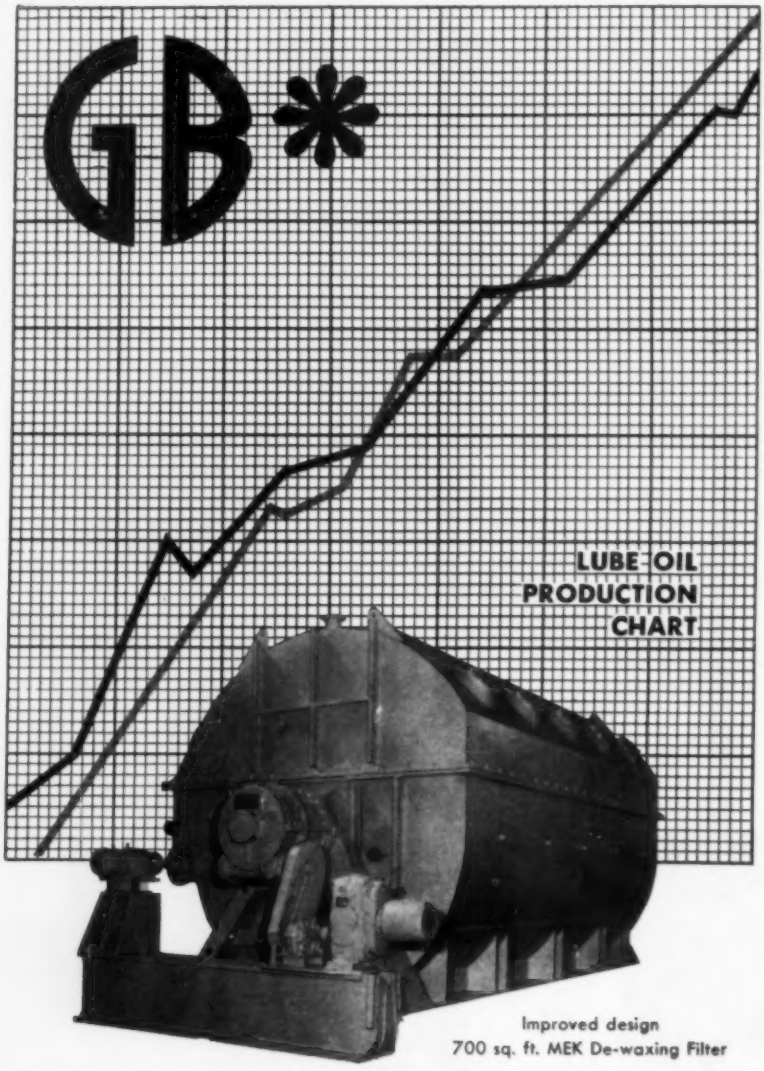

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G-B has manufactured more de-waxing filters than any other producer... by many times the largest volume in the industry.

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Personals

Harold R. Kemmerer, assistant manager of Shell Oil Company's manufacturing research department, has been named manager of the company's products application department. He succeeds **A. B. Culbertson,** who has retired. **J. D. Heldman,** special technologist in the manufacturing operations department, will replace Kemmerer.

Charles M. Cole Jr. has been named chief engineer for Tuloma Gas Products Company. He was formerly senior mechanical engineer.

Three technical staffmen of the Esso Research Laboratories, Baton Rouge, Louisiana, have been appointed "research associates." **Drs. C. L. Aldridge, Leo Broussard** and **H. M. Tenney** are the new associates in the "Ladder of Technical Staff Progression" recently adopted for advancement and recognition of professional personnel whose primary interests and talents are along technical lines. Previously, **Dr. Clark Adams** was named "research associate" and **Kenneth Draeger** "engineering associate" in the plan also in use by Esso Research and Engineering Company, Linden, New Jersey.

Donald O. Swan has been named an assistant general manager of Esso Standard Oil Company's manufacturing department. Swan has been assistant general manager of Esso's Baton Rouge Refinery. **Robert K. Dix** succeeds Swan at Baton Rouge. He has been operating superintendent of the refinery.

The American Oil Company has announced promotions in the manufacturing and the research and development departments. **Roscoe F. Stahl,** associate director of research at Texas City, Texas, has been named assistant manager of manufacturing economics with headquarters in New York City. He will report to **C. F. Feuchter,** formerly manager of planning, who assumes the new title of manager of manufacturing economics. **H. K. Wheeler,** assistant plant manager at the El Dorado, Arkansas, refinery, has been promoted to the newly created position of director of planning in the research and development department, and also will be located in New York City. **Guy L. Honeycutt,** operating superintendent at the Yorktown, Virginia, refinery, has been named assistant manager at El Dorado, succeeding Wheeler.

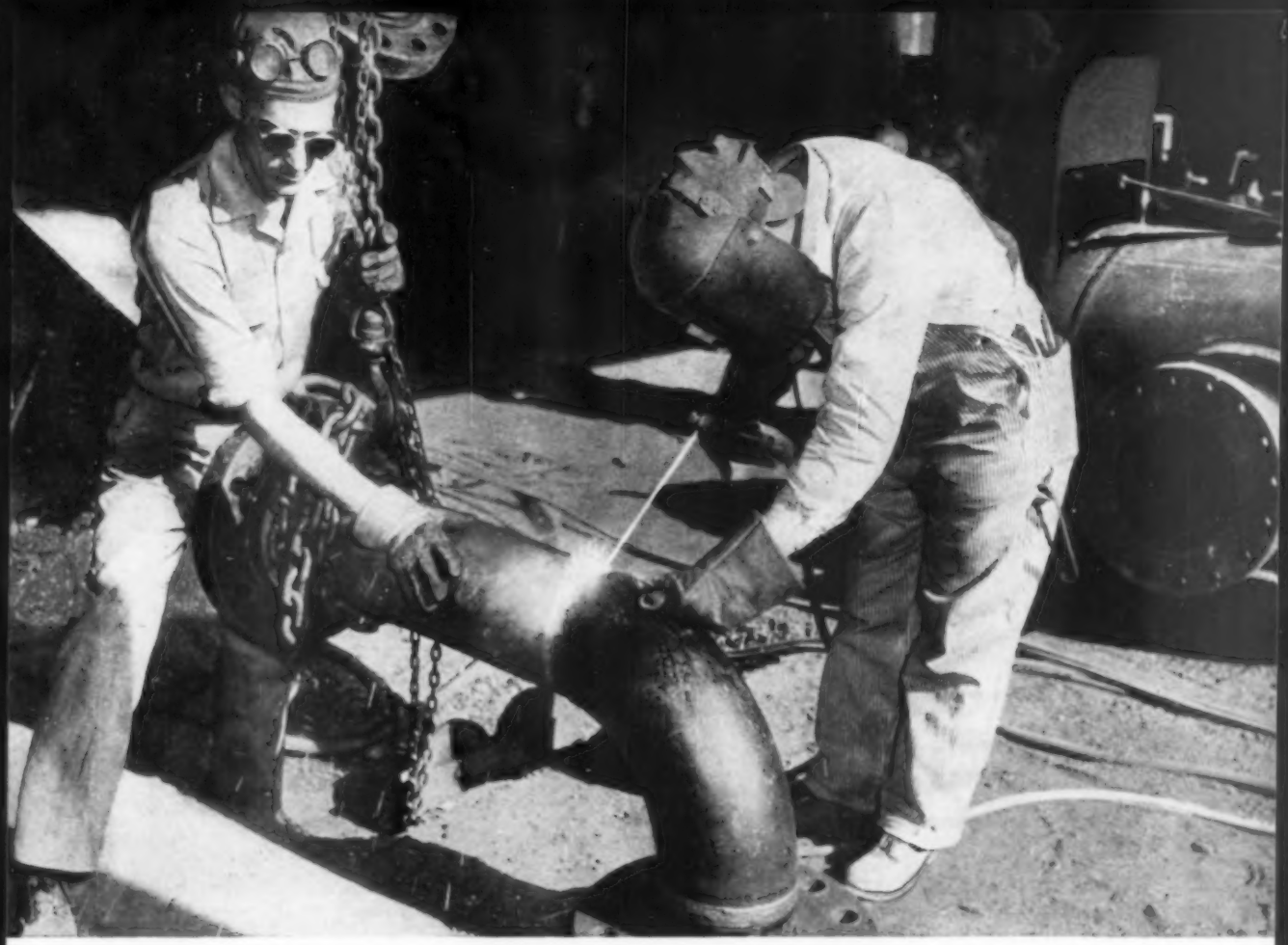
At Humble Oil & Refining Company's Baytown, Texas, refinery **A. J. Thaman** has been named superintendent of oil movements division. **B. D. Jones** has been promoted to assistant superintendent.

J. H. McClintock and **A. A. Sanders** have been promoted to senior chemical engineers in technical service division and **J. A. Snyder** and **E. L. Wilson,** to senior research chemical engineers in research and development divisions at Humble Oil & Refining Company's Baytown, Texas, refinery.

E. Q. Camp and **J. C. Schiller** have been promoted to assistant division heads in research and development division at Humble Oil & Refining Company's Baytown, Texas, refinery; **S. R. Bethea, M. R. Morrow, M. A. Mosesman** and **C. E. Zerwekh** have been named section heads in the same division.

Dr. Frederick G. Sawyer has been appointed vice president of Jacobs Engineering Company, Pasadena, California. Dr. Sawyer was formerly with The Ralph M. Parsons Company.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD



When Specs Demand Job Matched Piping and Fittings One Call Will Do it All—B&W

The layout has been made. Erection schedules are in the planning stage. What you do now in contacting a source of supply for your alloy steel pipe fittings and flanges, can very well be one of your most important moves.

If you call on B&W, you can be assured of benefits that simplify scheduling problems. With one call to B&W—on one order—you can obtain matched pipe, fittings and flanges to meet your specific requirements. What's more—the delivery of the alloy steel pipe, the seamless welding fittings, and the forged steel flanges that make up the integrated system you desire—can be coordinated. This is just one more reason why B&W has earned the reputation and acceptance as "the natural source" for alloy pipe and fittings.

Call on Mr. Tubes at your nearby B&W Tubular Products Division District Sales Office—let him coordinate your alloy steel pipe, seamless welding fittings and forged steel flange problems. He can help you. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pa.

TA-7009-PP3

Seamless and welded tubular products, seamless welding fittings and forged steel flanges—in carbon, alloy and stainless steel.

In
MODERN PETROCHEMICAL PLANTS

HEAT EXCHANGERS

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Qualified for Construction in Ferrous and Non-Ferrous Materials

Furnish MAXIMUM THERMAL EFFICIENCY

We are specialists in the field of custom design, fabrication, and repair of shell and tube HEAT EXCHANGERS for the Petroleum, Chemical, and Process Industries. We welcome an opportunity for quoting on your requirements.

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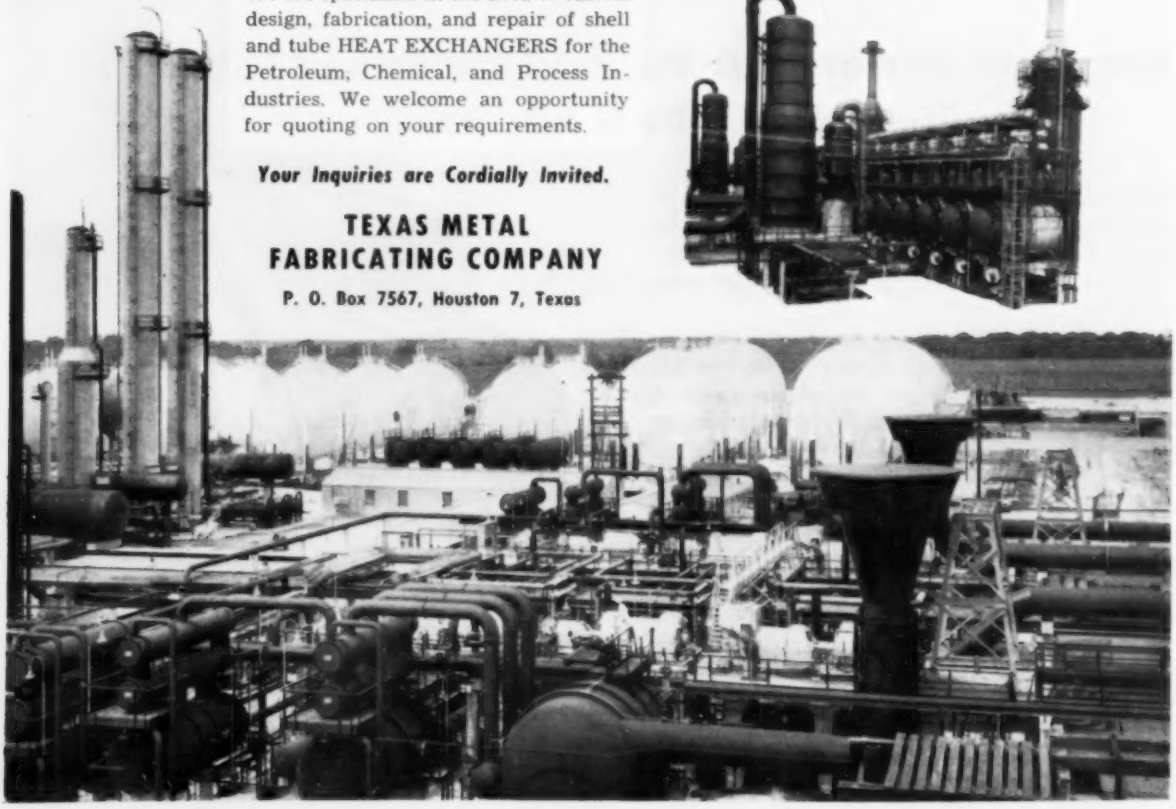


NEW Refining Equipment

• machinery • supplies • services

For more information on items described here in brief, use the handy reply card and circle the corresponding numbers

New Type Butterfly Valve. The new rubber seated valves are trade-named Darling-Pelton Butterfly Valves. Advantages claimed include: Lower operating torque,

adjustability of seat for tight shutoff, seat replacement without removal of shaft or operator, elimination of shaft sealing problems as the rubber seat is a continuous ring integral with the disc, and increased operating cycles.

Sizes from 4 to 72 in. for pressures in the 50 to 250 psi range are available. *Darling Valve & Manufacturing Co.*

Circle Number (41) on Reply Card.

Additive Improves Lubricant Performance. Oronite GA-10, a new synthetic gelling agent for industrial greases, makes possible the formulation of superior multipurpose and specialized grease lubricants that outperform the best of conventional greases. GA-10, a derivative of the miracle fiber ingredient, terephthalic acid, was first developed by Oronite's research affiliate, California Research Corporation, to meet the demand for grease lubricants that would stand up under the extreme temperatures, high loads, and high speeds of modern machinery.

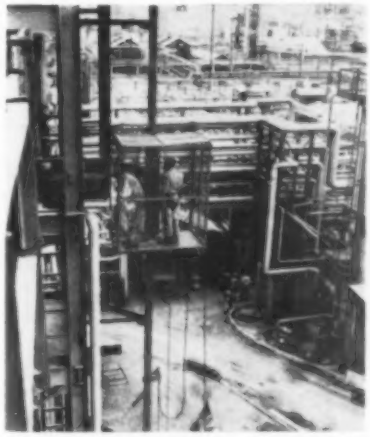
Compared to sodium stearate greases which have a dropping point between 375 F and 425 F, sodium GA-10 greases maintain their structure up to 600 F. GA-10 grease showed no emulsification after a week in a boiling water test, whereas sodium stearate greases disintegrate in 4-5 min. *Oronite Chemical Company.*

Circle Number (42) on Reply Card.

Steel Wedge Gate Valve. For water, steam, gas or air service at temperatures up to 850 F and for oil or oil vapor up to 1000 F, a new line of 600-lb steel wedge gate valves has been designed by Walworth Company. Valve body is of forged carbon steel.

The valves are available with screwed or socket welding ends. Those with a union bonnet are available in 8 sizes from ¼ to 2 in.; those with bolted bonnets, in 6 sizes from ½ to 2 in. *Walworth Company.*

Circle Number (43) on Reply Card.



Elevator for Construction, Turnarounds. The Hawkeye elevator operates on a vertical monorail and has a 2000 lb or 8 passenger capacity. It is simple to set up and operate and can be quickly dis-assembled and moved to another location and re-erected in a short time. Flexibility of unit permits extensive application in plants as a semi-permanent personnel and materials handling unit which can be mounted outside of structure. *Hawkeye Engineering Company.*

Circle Number (44) on Reply Card.

No. 91505, 60 cy. 115/230 volts
$275.00

No. 91500, same as No. 91505, but without motor or base
$220.00

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The most complete line of scientific instruments and laboratory supplies in the world

Here's a vacuum pump that is so carefully designed . . . so expertly machined . . . so perfectly balanced . . . that vibration has been reduced to an absolute minimum. Result . . . smooth, quiet operation. You can hardly hear it as it runs. In fact, its noise level is lower than that of any similar pump.

The new Cenco Hyvac-7 has more pumping capacity per cubic foot of space occupied than any other vacuum pump now available. It produces a free air displacement of 70 liters per minute and a guaranteed ultimate vacuum of 0.1 micron. This pumping speed in the low micron range is exceptionally high. The ratio of pumping speed at 1 micron to that at atmospheric pressure is 49%. And it pumps from atmospheric to ultimate pressure in less than five minutes.

This finest, most efficient of all vacuum pumps is now ready for shipment.

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PRESSURE CONTROLS

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Low Operating Pressure—High Over-Range Protection

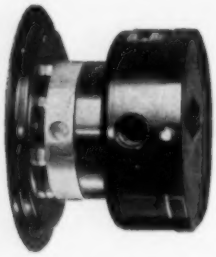
• EXAMPLE APPLICATIONS

1. Provide low suction protection on pumps where suction pressure may go to very high line pressures (up to 2,500 psi.)

2. As an interlock to prevent a door to a pressure chamber from being opened until the pressure has dropped to atmospheric pressure (1" H2°) with over-range protection to 600 psi.

• TWO SERIES AVAILABLE

Series DA-900: Bourdon tube operated. Over-range protection to 2,500 psi. Operating ranges 0-60 psi; 0-100 psi; 0-150 psi; 0-300 psi.



Series CP: Diaphragm operated. Over-range protection to 600 psi. Operating ranges 1"-60" pressure or 1"-60" vacuum.

Both types available in various style cases.

SEND IN YOUR CONTROL PROBLEM OR WRITE FOR BULLETINS CA-21 & CA-1P

THE MERCOID CORPORATION
4211 Belmont Ave., Chicago 41, Ill.

New Literature

Plant Facilities Presented In Booklet. Chicago Steel Tank Company has prepared a 32-page color brochure describing their operations. The booklet is calculated to be of special interest to design engineering and other equipment buying persons in the process industries. Personal inspection of the firm's facilities, often impractical due to time and distance, can now be accomplished through the pages of this brochure. Described in the booklet is all major fabricating equipment, their capacities for thickness, length and width, tonnage, etc. *Chicago Steel Tank Company, Division of U. S. Industries, Inc.*

Circle Number (45) on Reply Card.

New Allis-Chalmers Bulletin. Specifications for Allis-Chalmers lift trucks, towing tractors and platform trucks are given in Bulletin BU-450 now available from the Buda Division. Basic models are pictured in the bulletin which also includes a load rating chart covering the complete line of lift trucks. *Buda Division, Allis-Chalmers Manufacturing Company.*

Circle Number (46) on Reply Card.

Spectrochemical Analysis. New 24-page brochure describing a variety of prism and grating spectrographs, and related accessories, features data on the design, application, and characteristics of each type of instrument; plus specification tables and graphs permitting quick comparison of individual performance ranges. *Jarrell-Ash Company.*

Circle Number (47) on Reply Card.

Bulletin Describes Sweetening Process. The Petreco-Bender Catalytic Sweetening Process is the subject of a 4-page literature sheet issued by the Petreco Division of the Petrolite Corporation. The process is described as a modern way to sweeten light hydrocarbons by converting mercaptans to disulfides through oxidation.

How the Petreco-Bender Process works, expected through-put of the system, estimated cost of operation and chemical requirements are just a few of the subjects discussed in the new bulletin. *Petreco, Division of Petrolite Corporation.*

Circle Number (48) on Reply Card.

Delivery System for Bulk Gases. New, 16-page pamphlet discusses the bulk delivery method of handling industrial gases in large quantities. Catalog 450, entitled "Bulk Gas Delivery System," illustrates the several types of delivery units and explains the advantages of each. Diagrams show various plans for trailer unit parking and indicate the yard space required by each. *Air Reduction Sales Company, Division of Air Reduction Company, Incorporated.*

Circle Number (49) on Reply Card.

Operations and Services Brochure. New 16-page brochure outlining the operations and services of the Portland Copper & Tank Works is now available. The illustrated booklet reviews company history and operating methods, and describes Portland Copper's technical advances in the fabrication of stainless steel and high temperature alloys in connection with its work for the aviation, pulp and paper, chemical and petroleum industries. *Portland Copper & Tank Works, Inc.*

Circle Number (50) on Reply Card.

Compressors for Gas Processing. New technical bulletin on its Series RS Centrifugal Compressors for gas processing work is announced by Cooper-Bessemer. The 24-page bulletin gives complete construction details, engineering application data, and dimensions. *The Cooper-Bessemer Corporation.*

Circle Number (51) on Reply Card.

Fabricating the Stainless Steels. New 12-page special issue of Eutectic's semimonthly Technical Information Digest (TIS 2818) is now available. The manual discusses the metallurgy of the different stainless steels. Data are developed to help the welder prevent weld weakening intergranular corrosion thus preventing reduced resistance of the stainless steel to aqueous, corrosive solutions. *Eutectic Welding Alloys Corporation.*

Circle Number (52) on Reply Card.

Carrier-Mounted Crane. Power crane and shovel manufacturer Schield Bantam Company announces the availability of an up-to-date 6-page bulletin covering the Bantam Model T-35 crane-excavator. The 2-color bulletin features application and engineering data on the company's 7 and 8-ton carrier-mounted machines, as well as brief specifications and illustrations of the 3 crane carriers, Models 100, 200 and 300. Easy-to-read charts and illustrations give dimensions and operating data on the shovel, back hoe, clamshell, dragline and crane attachments. *Schield Bantam Co.*

Circle Number (53) on Reply Card.

Helpful Data for PVC Fittings and Flanges. Technical data and installation information on unplasticized polyvinyl chloride (PVC) pipe are provided in a new booklet. It also gives complete specifications for threaded and socket types of PVC fittings, valves and flanges made of both normal and high impact material.

Booklet contains pressure-temperature charts, chemical resistance tables, support spacing formulas and lists leading industrial organizations that are now using PVC piping in increasing amounts. *Tube Turns Plastics, Inc.*

Circle Number (54) on Reply Card.

for **leakproof, pressure-tight connections**

use **TiteSeal®**

SEALING COMPOUNDS

Heat and vibration-proof, non-solvent, will not shrink, crack or crumble. Makes all assemblies leak-proof and pressure-tight. Prevents rust, corrosion, joint seizure.

7 BASIC BLENDS

LIQUID WRENCH®

The super-penetrating rust solvent

LOOSENS

rusted bolts, nuts, screws, 'frozen' parts

Liquid Wrench works *fast*... yet is absolutely safe for all metals and alloys.

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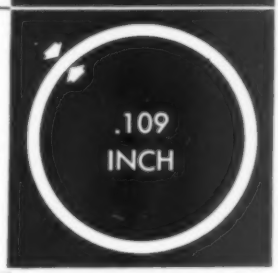
At Industrial, Automotive, Hardware, Plumbing Jobbers

RADIATOR SPECIALTY CO.
Charlotte, North Carolina

SOLDER SEAL

Why pay extra for this.....

When you need only this.....



Armco supplies Welded Steel Pipe to meet requirements in the Natural Gasoline and Natural Gas Divisions and wherever else you need dependable line pipe.

When your pipeline calls for light wall pipe, you can easily get what you need from the wide range of wall thicknesses available in Armco pipe.

Many lines such as gas gathering lines for natural gasoline plants, gasoline plant piping, and residue gas lines do not require expensive, heavy wall pipe. Yet the lightest wall pipe available from many suppliers is $\frac{1}{4}$-inch wall thickness.

Armco Pipe is supplied in many thicknesses from $\frac{9}{64}$- to $\frac{1}{2}$-inch. You select what you need without paying for excess metal. Also, you can choose from 20 different diameters of Armco Pipe, ranging from 6 to 36 inches.

WRITE FOR DATA

Write for complete information applied to your needs. Armco Drainage & Metal Products, Inc., Welded Pipe Sales Division, 3647 Curtis Street, Middletown, Ohio. 201 KOME Building, Tulsa, Oklahoma. Subsidiary of Armco Steel Corporation. Export: The Armco International Corporation.

ARMCO WELDED STEEL PIPE

ARMCO®

If you are a pipeliner

you'll appreciate this self-sealing gasket in UNIBOLT scraper trap and blowdown closures

Little things . . . like the gasket for a scraper trap or blowdown closure for example . . . can be a big headache. But not this one. It is the self-sealing gasket used in UNIBOLT pipeline couplings. The UNIBOLT design makes line pressure do the sealing. And this design practically encloses the gasket in steel so that when the closure is opened and closed the gasket is hardly disturbed. Made of oil- and gas-resistant Hycar nitrile rubber, this gasket will last indefinitely under normal conditions.

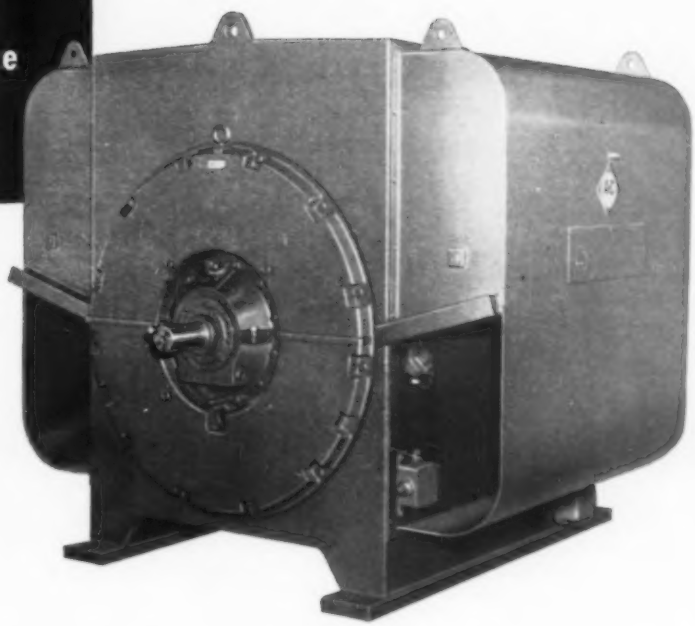
UNIBOLT scraper trap and blowdown closures are hinged for easy operation. Release only two bolts and the closure swings open and shut like a door. No heavy lifting. No time-consuming multi-bolt flanges. Write for complete information.

THORNHILL CRAVER CO.

P. O. Box 1184, Houston, Texas

Eliminate costly enclosures with Allis-Chalmers weather-protected MOTORS

Modern features
cut operating, maintenance expense . . . give MORE dependability



Here's a newly designed line of Allis-Chalmers weather-protected motors with the ability to "take" outdoor conditions. This means no expensive protective enclosures are needed . . . a big saving in plant or installation building costs.

Designed to meet defined NEMA requirements, these motors incorporate many important features which assure dependable outdoor operation:

- **Ventilating System** — Low velocity intake, vertical lift, change of direction and high velocity discharge of ventilating air keep rain, snow, sleet, dust and dirt out of vital parts.
- **Removable Air Ducts** — To facilitate inspection and maintenance of interior air passages, air intake ducts are designed for quick removal.
- **Stator Assembly** — Removable as a unit, it simplifies maintenance and minimizes downtime.
- **Split Sleeve Bearings** — Capsulized design permits access to motor interior without disturbing the bearings or their enclosures. Positive vapor seal is used on high-speed motors. Antifriction bearings are available for slow speed motors.
- **Proven Insulation** — Famous Allis-Chalmers insulation systems (Class A and B) are available. And, for extreme temperatures, or where high resistance to abrasion and moisture is required, Allis-Chalmers can provide the revolutionary *Silco-Flex* system.

Silco-Flex is an Allis-Chalmers trademark.

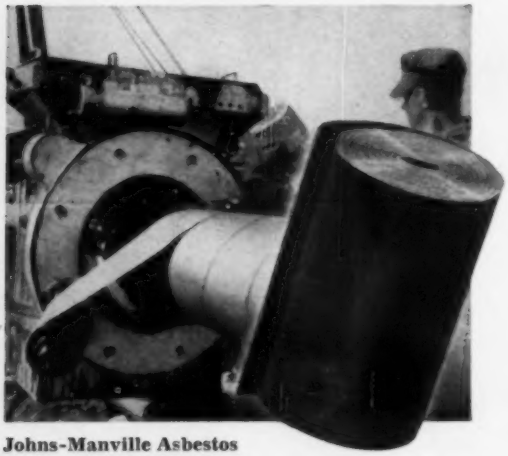
THIS DESIGN available in ratings from 250 to 900 hp. Other designs in larger horsepower ratings are also available. Contact your A-C sales office or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin. Ask for Bulletins 51B8606A and 05B7894.

A-5292

ALLIS-CHALMERS

Like the "dillo's" tough shell that shields him so well...

Johns-Manville Asbestos Wrap shields oil and gas pipeline coatings



Johns-Manville Asbestos Felt is available in 3 types for field application or mill wrapping:

#15 Asbestos Felt—the high-strength, uniform asbestos wrap that has given superior protection to pipe coatings for more than 30 years—under the most severe soil conditions.

#15 Transhield®—heavyweight asbestos felt with parallel glass reinforcement for high tear strength.

#8 Transhield—standard-weight asbestos felt with parallel glass reinforcement—for low-cost protection against average soil conditions.

J-M Asbestos Wrap provides the strong protection a strong coating deserves and needs. It offers the most effective single protection against damage—prolongs the working life of the pipeline coating. Here's why:

Asbestos is an ageless mineral . . . the fibres are strong and tough—cannot rot or decay. As used in J-M Wraps, the asbestos fibres are felted, then impregnated with a cold tar or asphalt saturant to form literally a flexible covering of stone. Like the "dillo's" tough shell that shields him so well—the enduring, "stonelike" J-M Asbestos Wrap shields pipeline enamels from earth loads, soil stress, and other forces that weaken coatings and permit corrosion of the pipeline.

Invite one of our engineers to show you the results of the three-year, extensive test program on "Pipe Line Coatings and Wrappers." Write to Johns-Manville, Pipe Division, 22 East 40th Street, New York 16, N. Y.

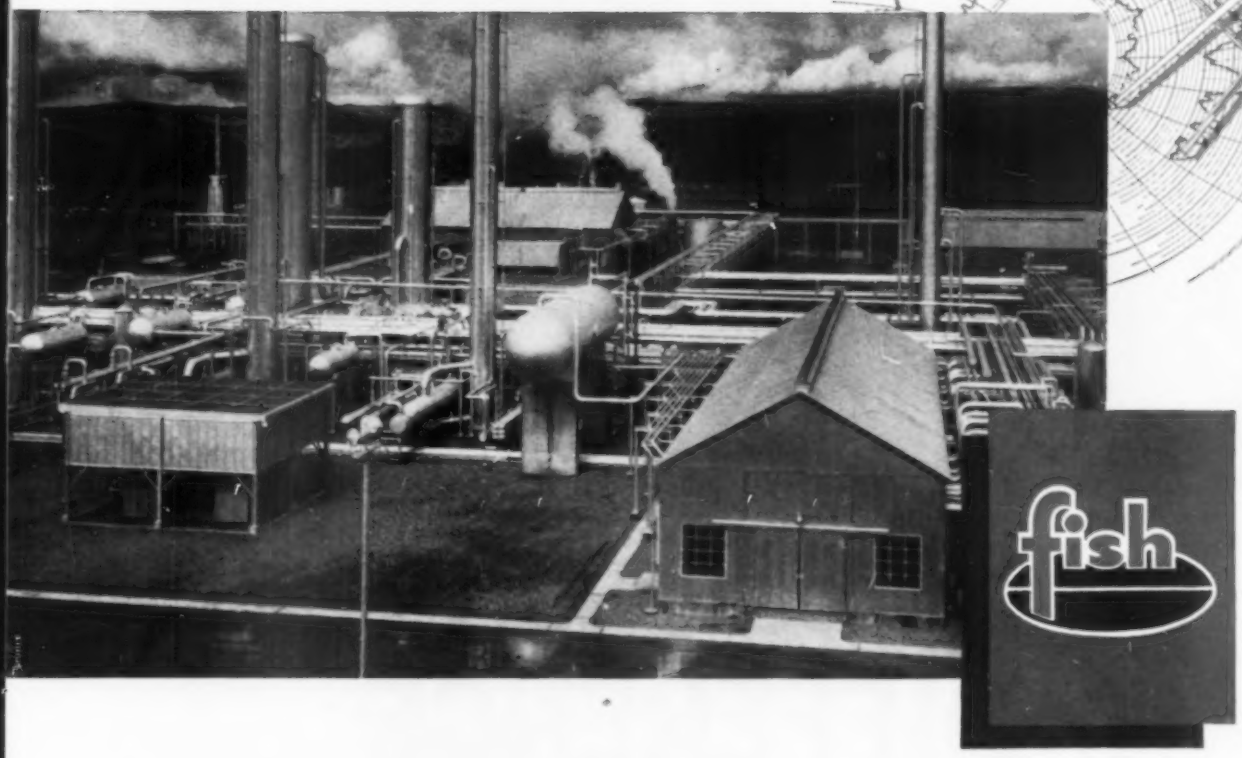
✓ STRONG PROTECTION • PROVEN PERFORMANCE
RESISTANCE TO SOIL STRESS AND DEFORMATION
HIGH-SPEED APPLICATION • LONG-TERM INVESTMENT
SIMPLIFIES CATHODIC PROTECTION SYSTEMS
REDUCES HAZARD • INCREASES SAFETY

Johns-Manville PRODUCTS FOR PIPELINE PROTECTION

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

This gasoline plant operates efficiently despite

varying loads



The San Juan gasoline plant of the Pacific Northwest Pipeline Corporation is big! It was designed to handle 300 million cubic feet of gas per day and recover 340,000 gallons of liquids. But efficient operation over a wide range of loads was necessary.

Since it was placed on stream in October, 1956, the San Juan plant has operated efficiently and dependably at loads ranging from 20 per cent to nearly 100 per cent of capacity. This is an unusual record for a plant of this size.

Furthermore, because of a rigid timetable imposed by pipeline commitments, the plant was constructed in record time despite many unusual problems posed by terrain, weather and transportation.

Because of transportation limitations, the 90-inch by 56-foot absorbers had to be shipped to the site in sections. There, welding assembly was completed in the field. The units were then inspected and stress-relieved.

This is just one example of the way the Fish Companies tackle problems. Your problem may be entirely different.

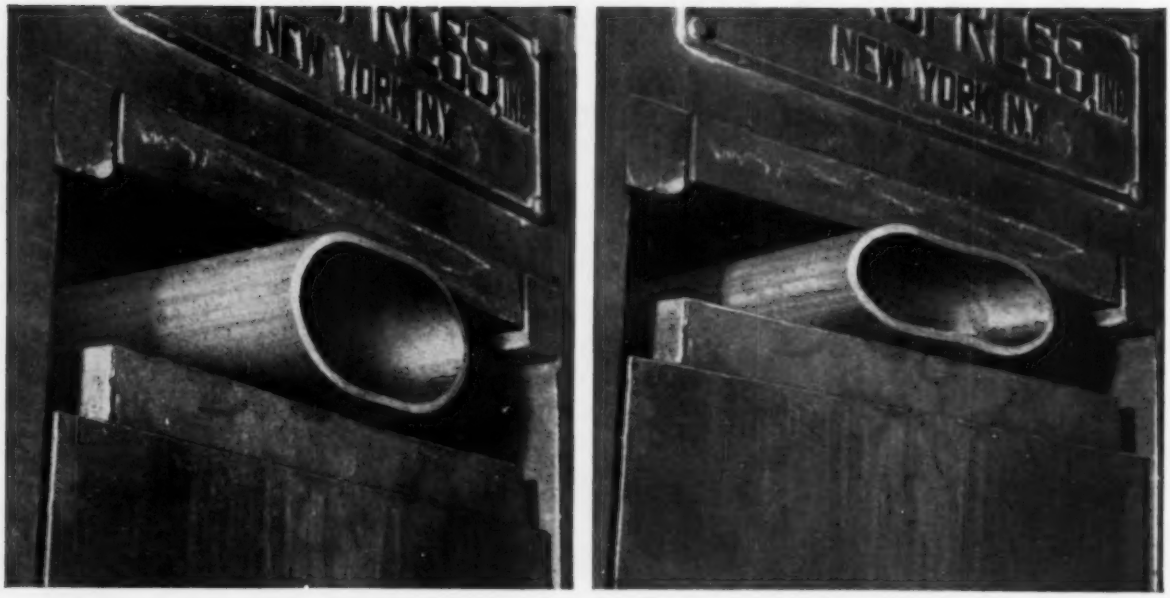
If you are planning new facilities in oil, gas or chemicals, call on Fish for imaginative engineering . . . from feasability study to final completion.

the fish companies

HOUSTON

FISH ENGINEERING CORPORATION
FISH NORTHWEST CONSTRUCTORS, INC.
FISH SERVICE CORPORATION

DUCTILITY



MAKES THE DIFFERENCE

when Kaiser Pipe meets the press!

ONLY the soundest welds, joining an extremely ductile steel, could stand the strain of the pipe-flattening test shown here.

We know, of course, that no electric weld pipe would ever be subjected to such rigorous conditions in the field.

Still, at Kaiser Steel we want to be *sure*.

So—52 times along the way from iron ore to finished pipe—we run exhaustive tests to keep the quality high.

We measure our pipe's strength and ductility. We inspect it thoroughly for roundness... concentricity... accuracy of dimension.

Thus, when you specify electric weld pipe from Kaiser Steel, you can be *certain*. Certain of performance to match your most exacting demands. Certain, too, of service when and where you need it.

Kaiser Steel
built to serve the growing West

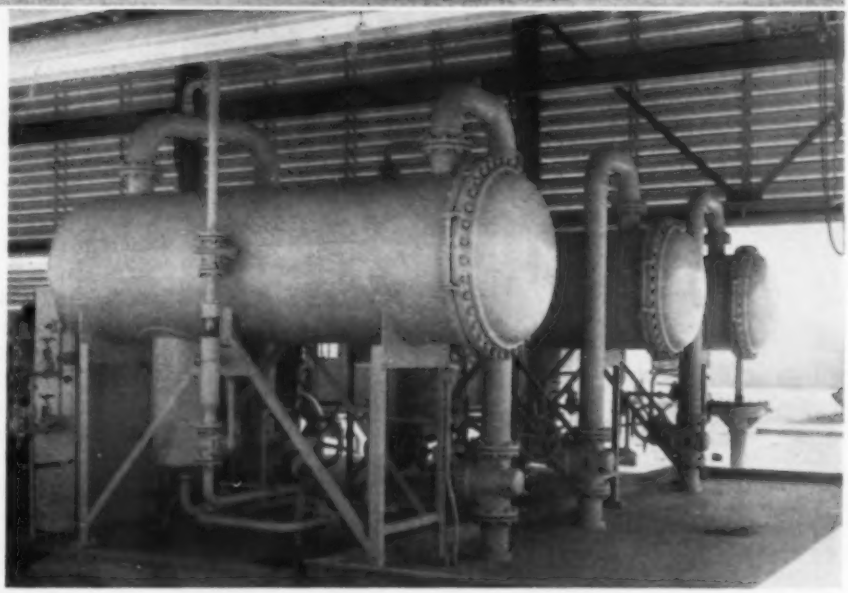
Steel Mill Products: plates • hot rolled strip and sheet • cold rolled strip and sheet • tin plate • continuous weld pipe • electric weld pipe • alloy and carbon bars • bar shapes • structural shapes semi-finished steels • pig iron • ingot molds • coke by-products • **Fabricating Division:** steel fabrication for construction, aircraft, missile and other industries • expanded fusion weld pipe reinforced concrete pipe • tanks • For specifications, write: **KAISER STEEL CORPORATION** • **Los Angeles** • **Oakland** • **Seattle** • **Portland** • **Phoenix** • **Denver** • **Tulsa** • **New York**

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

SOUTHERN PACIFIC PIPE LINES, INC.

select EXCEL-SO

water separators and meter calibrating tanks*



WARNER LEWIS COMPANY

BOX 3096 • TULSA, OKLAHOMA

DIVISION OF FRAM CORPORATION

*These two famous EXCEL-SO pipeline products insure maximum product cleanliness and meter accuracy— eliminate costly corrosion and meter repairs

High volume strainer/separators and large capacity meter calibrating tanks for a complete range of petroleum products—all in high pressure design where required—a specialty with the Warner Lewis Company. Years of experience in design and fabrication of this equipment for pipeline service are available for assistance in planning your installation. Write Warner Lewis Company for further information.

Representatives in all major cities
In Canada, From Canada Ltd
Stratford, Ontario

HYDRANTS FOR PLANT PROTECTION

Types and sizes for every requirement

YOU'LL be ahead on many counts when you specify modern Darling Fire Hydrants. Just for example . . .

Your system can include hydrant types exactly right for special or unusual service needs — breakable coupling types where traffic damage is common, concealed flush types for airport and pavement installation, Tee-base types to eliminate lateral connections where practicable. These and a few of the other types are shown here.

Equally important, Darling's unique B-50-B development (now available in all except the Tropical type) introduces *ball-bearing* operation combined with "O" ring seals. Result: a packless, dry-top hydrant. No packing gland maintenance. Operating threads and bearings *stay* lubricated and water can't reach them. Operation is far easier, far faster . . . and you avoid lots of maintenance time and trouble.

Send for complete information. Better still, ask to have a Darling engineer check your needs and tell you just what you stand to gain with Darling Hydrants.

TRADE DARLING MARK

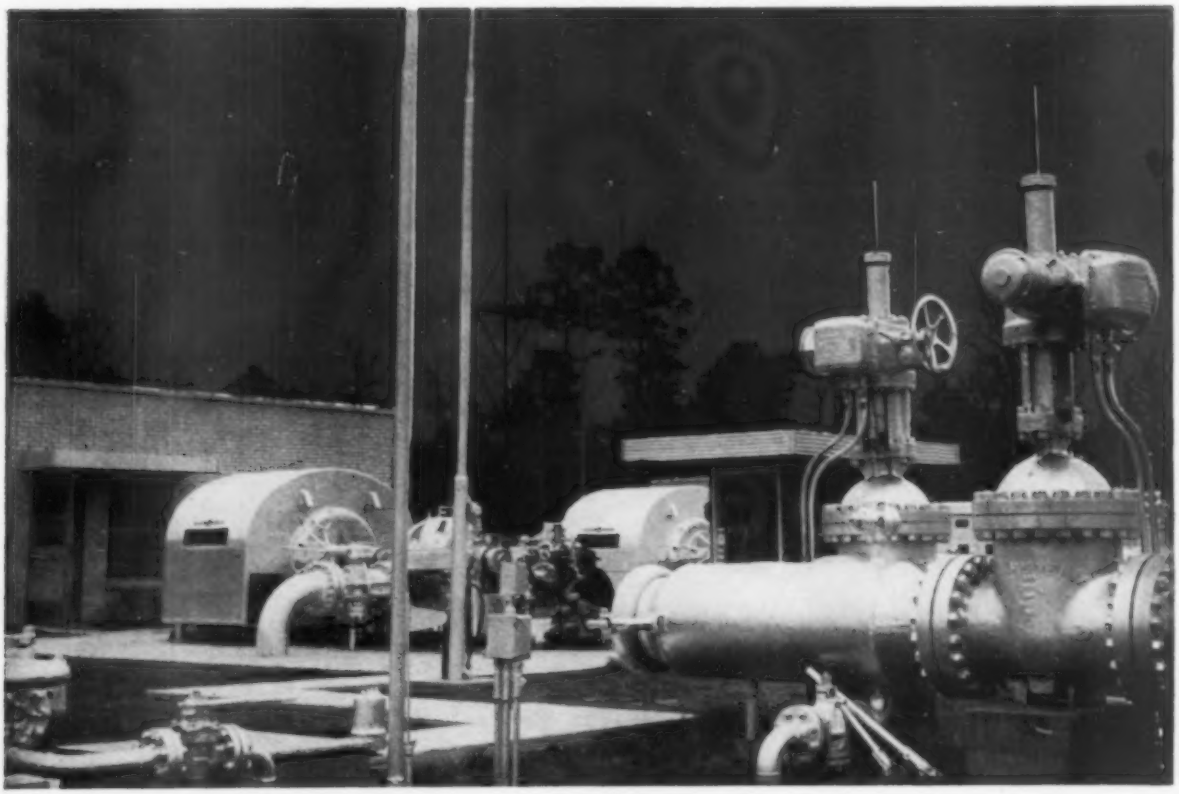
DARLING VALVE & MANUFACTURING CO.

Williamsport 2, Pa.

Manufactured in Canada by The Canada Valve & Hydrant Co., Ltd., Brantford 7, Ont.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

PIPE LINE PUMPING MAKES WONDERFUL CHANGE WITH ELECTRIC POWER



Operated by Remote Control

There are over 686,000 miles of pipe line throughout America today – three times the total U.S. railroad trackage. Reason for this big boom is economy of transportation. Closely linked with the economy picture is UTILITY ELECTRIC POWER – the power that has made push-button, fully automatic pipe line operation possible. When you have deliveries to make on schedule – at low cost – without the usual worries of station down-time, etc. – USE UTILITY ELECTRIC POWER. It's the sure way to be modern, more progressive and make more money.

I'M LCP – Low-Cost Power on the Job 24 Hours Daily

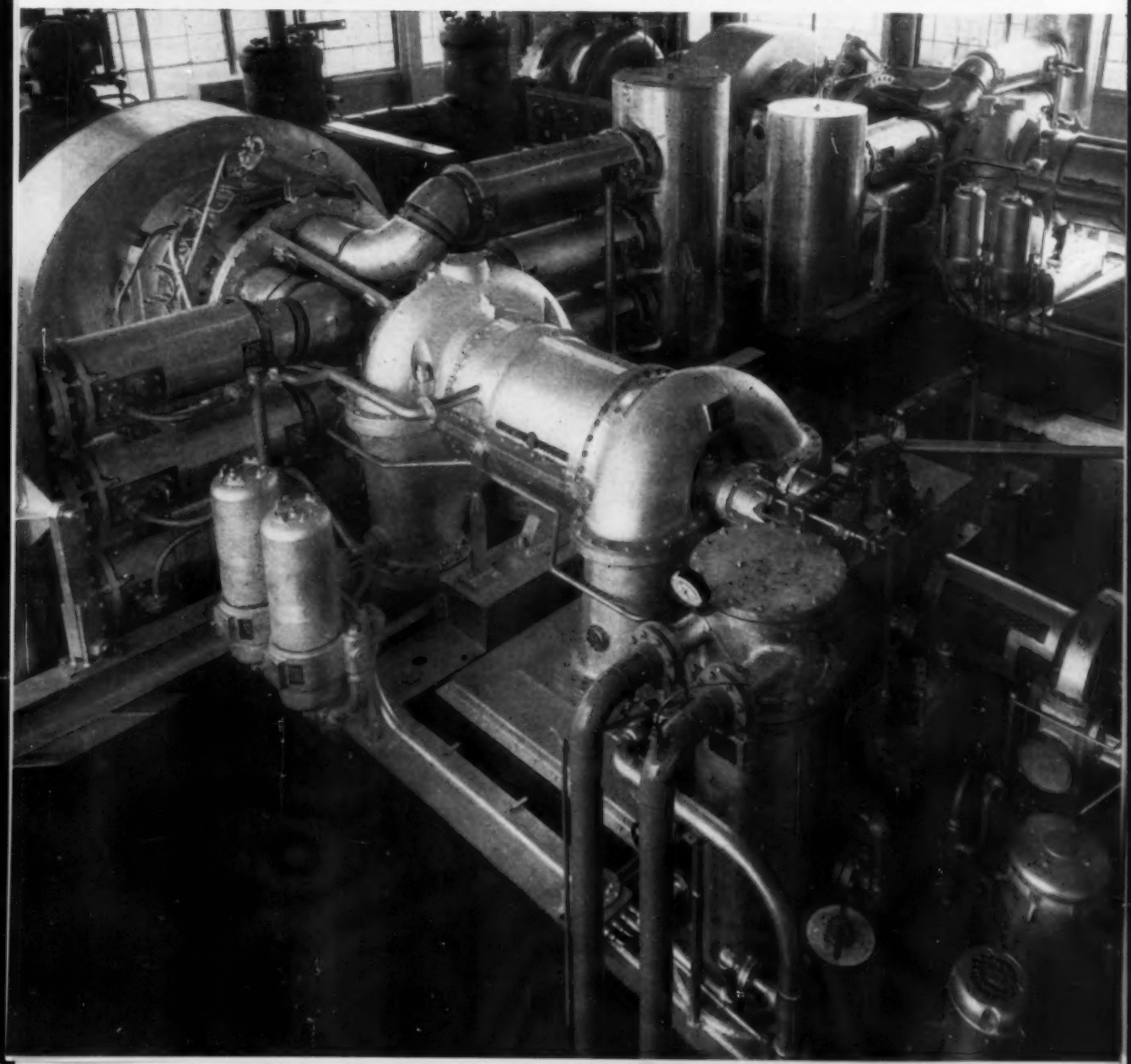
PETROLEUM ELECTRIC POWER ASSOCIATION

P. O. BOX 2771 DALLAS, TEXAS

Pipeline industry's installed at

TURBINE CONTROL is centralized in one convenient, easily accessible location. One switch initiates automatic starting and stopping sequence for the drive system.

VERSATILITY of General Electric gas turbines permits installation of ducts and pipes below floor level. Higher rated gas turbine units provide lower over-all costs.



largest horsepower gas turbines Texas Eastern's Athens, Ohio station

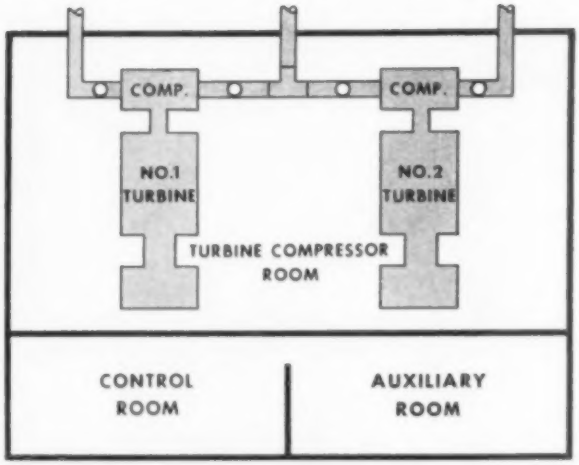
General Electric 7600-hp gas turbine drives provide lower dollars-per-horsepower installed cost, reduced operating costs with improved combustion system

Installed in Texas Eastern's Athens, Ohio station are two of the largest gas turbine units ever used to drive gas pipeline compressors. The new station, one of two duplicate stations put on stream by Texas Eastern, also has other unique features helping to provide efficient operation as well as station flexibility.

TURBINE HORSEPOWER: Each one of the two gas turbines in the General Electric drive system is a 7600-hp unit, largest ever used on gas pipeline applications. These new and larger units provide a lower $-per-horsepower installed cost because there is more horsepower in a given space. In addition, these General Electric turbines operate at better efficiency due to an improved combustion system.

STATION ARRANGEMENT: The new station's regenerator and air filters are located to the side of each turbine rather than axially in line with the turbines. This arrangement permitted straight through piping between compressor units with corresponding minimum pressure losses. A neat installation, with all pipes and ducts running below the floor, was also accomplished. There is no sacrifice in the ability to easily expand the station when load requirements demand it.

TO HELP YOU SOLVE your station drive requirements, General Electric makes available to you complete engineering services. As with the Texas Eastern installation, G-E engineers will help design and install the drive system that exactly meets your station requirements. Get complete information from your nearest General Electric Apparatus Sales Office—and meanwhile write for bulletin GEA-5516B, "Combustion Gas Turbines," to General Electric Co., Section 661-55, Schenectady, N. Y.



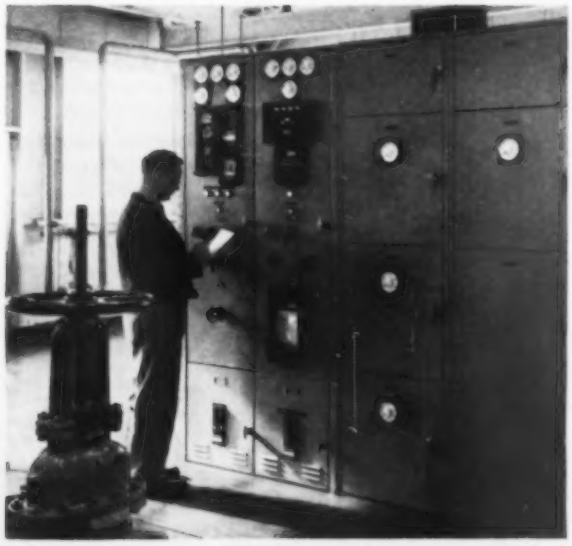
STRAIGHT PIPE reduces to a minimum pressure loss between units. Both of new stations utilize straight piping and, in addition, place station's air filters and regenerators to the side, rather than axially in line with the G-E gas turbines.

*Registered trade-mark of General Electric Co.

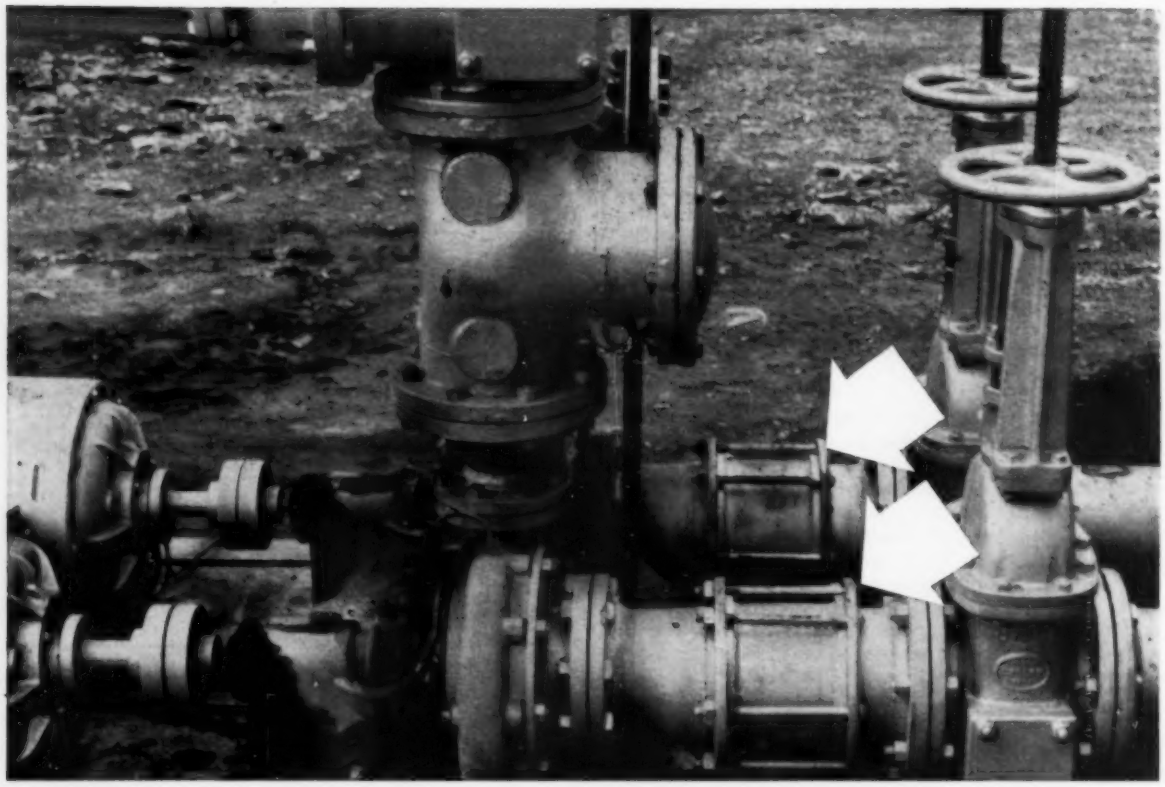
Engineered Electrical Systems for Pipeline Pumping

GENERAL ELECTRIC

MORE EFFICIENT General Electric gas turbine drive system was the result of close co-operation between Texas Eastern personnel and General Electric Company engineering services.



COMPACT, FACTORY ASSEMBLED General Electric Cabinetrol* panels centralize station's auxiliary equipment, are designed to take up minimum of station's valuable floor space.



Speed up installations and line repairs . . . the DRESSER way!

Dresser Couplings and Repair Products make short work of dozens of installation and maintenance problems. For instance:

Two man-minutes per bolt is all the time needed to install the Dresser Couplings shown above. They make vibration-absorbing connections that stay permanently tight. For fast connections and repairs of all types of transmission piping, Dresser Couplings and Long Sleeves are ideal. Complete size and pressure range.

To repair a porous weld, without shutting down the line, use a Dresser Porous Weld Clamp. Put it around the weld, draw up the bolts. It's that simple. Sizes 2″ through 31″.

For quick repairing of breaks, splits and holes in high pressure lines, use Dresser Split Repair Sleeves. No loose parts. No welding. Self-sealing end-gasket pressure increases as line pressure increases. Sizes 6″ through 24″ and larger.

For reinforcing welded joints, use Dresser Reinforcing Sleeves, made of best grade flange-quality steel plate. Vented against pressure build-up. Also available for coupled joints.

It always pays to stock Dresser Couplings and Repair Products. Buy them from your piping supplier or write us direct at the nearest address given below. Write today for catalog.

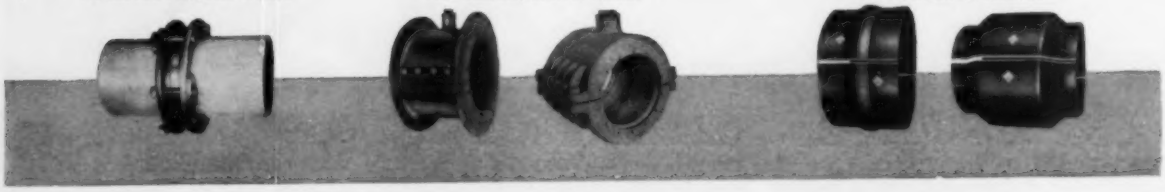
DRESSER®

Dresser Manufacturing Division, 49 Fisher Ave., Bradford, Pa. Warehouses: 1121 Rothwell St., Houston; 101 S. Airport Blvd., S. San Francisco. In Canada: 1211 Bathurst St., Toronto; 1210 11th Ave., W., Calgary.

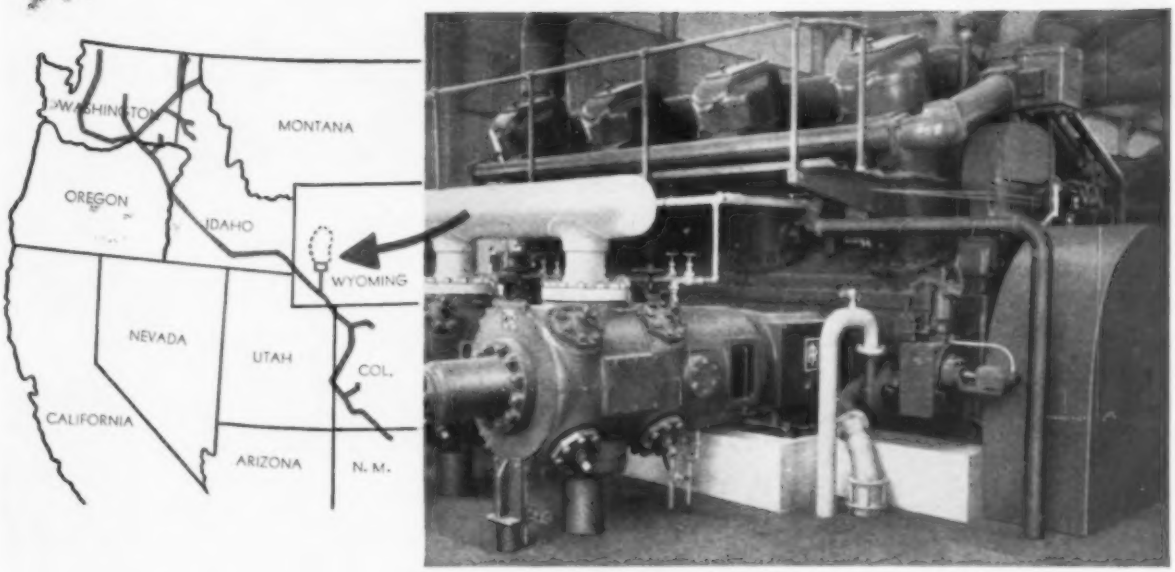
TO REPAIR POROUS WELDS

FOR BREAKS, SPLITS, HOLES

REINFORCING SLEEVES



A NEW HIGH FOR I-R GAS-ENGINE COMPRESSORS



One of seven KVG Gas-Engine Compressors at Big Piney Station of Pacific Northwest Pipeline.

Seven KVG Units at 7,325 ft. altitude deliver gas from **BIG PINEY FIELD** to Pacific Northwest Pipeline

The Big Piney Station of the new Pacific Northwest Pipeline system is of special interest for two reasons.

Located at an elevation of 7,325 ft above sea level, it is the highest pipeline compressor station in the country—operating in temperatures ranging down to 40° below zero.

It has made possible the commercial utilization of Big Piney Field, which has been shut in for the past 18 years by lack of transportation facilities.

Hence it was quite appropriate that opening ceremonies for the Pacific Northwest Pipeline were held at Big Piney—where seven Ingersoll-Rand KVG Gas-Engine Compressors boost field gas to pipeline pressures. Two 880-hp units and two 660-hp units operate with intake pressures of 100-350 psi and discharge pressures of 400 to 550 psi. Three more 660-hp units have intake from 400 to 550 psi and discharge pressures of 650 to 850 psi.

Because of the extremely high altitude, the gas engines were supplied in bigger-than-normal sizes. Combined rated horsepower of the seven Big Piney units would be 5,060 hp at normal 1,000 ft altitude—for an actual load of about 3,885 hp under average conditions. The station is completely "winterized" for dependable operation at sub-zero temperatures.

Ingersoll-Rand Gas-engine Compressors now serving the various stations of the Pacific Northwest Pipeline include the following types and sizes:

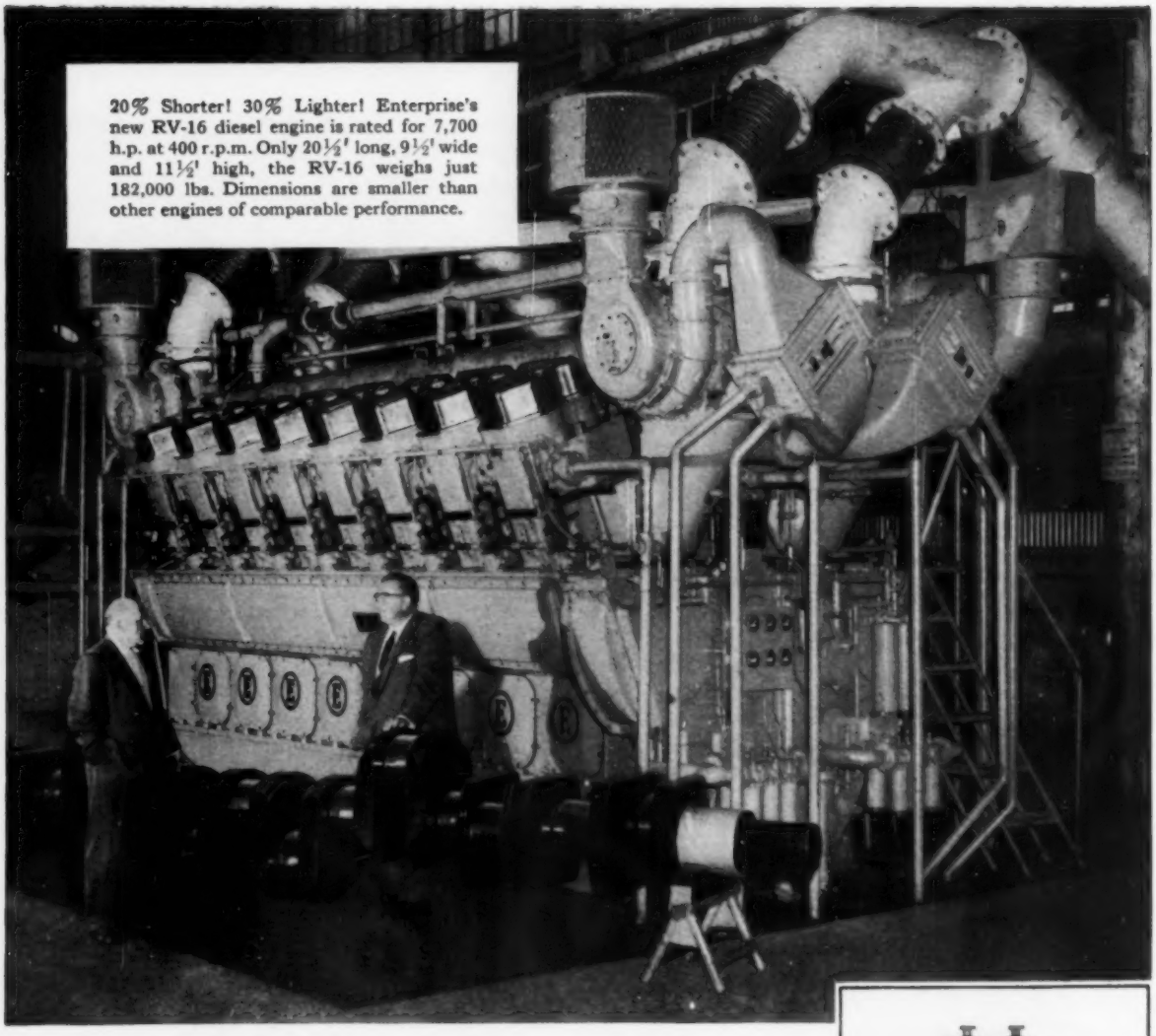
SVG compressors, 330 hp
KVG compressors, 660 and 880 hp
Turbocharged KVS units, 1000 and 2000 hp
PKVG Gas Engine Power Units, 1100 hp

For maximum stability, flexibility and long-range economy under all pipeline conditions, it pays to specify Ingersoll-Rand four-cycle gas-engine compressors. Your I-R representative will gladly give you complete information on the units best suited to your needs.

Ingersoll-Rand
11 Broadway, New York 4, N. Y.

6-466

COMPRESSORS • AIR TOOLS • ROCK DRILLS • TURBO-BLOWERS • CONDENSERS • CENTRIFUGAL PUMPS • GAS & DIESEL ENGINES



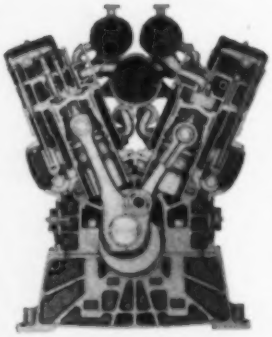
20% Shorter! 30% Lighter! Enterprise's new RV-16 diesel engine is rated for 7,700 h.p. at 400 r.p.m. Only 20½' long, 9½' wide and 11½' high, the RV-16 weighs just 182,000 lbs. Dimensions are smaller than other engines of comparable performance.

Enterprise Chooses KOPPERS Piston Rings Exclusively for RV-16

Prototype of a new line of industrial diesel engines, the RV-16, built by Enterprise Engine & Machinery Co., of San Francisco, is designed for such rugged operations as delivering main propulsion in towboats and seagoing freighters, or supplying power for pumping stations or electric generation.

As many other leading manufacturers have done, Enterprise has selected Koppers Piston Rings exclusively. Koppers wide range of types and sizes . . . variety of material selection . . . control of material quality . . . close tolerance performance . . . rigid standards of inspection—all contribute to Koppers leadership in the field of industrial piston and sealing rings, making Koppers the most dependable source of supply.

If you have a problem of ring application, avoid further needless expense. Take advantage of Koppers experience, research facilities and craftsmanship. Write for information today. KOPPERS COMPANY, INC., Piston Ring and Seal Department, 710 Hamburg Street, Baltimore 3, Maryland.



Cutaway shows internal design of the RV-16

KOPPERS

AMERICAN HAMMERED
Industrial Piston Rings
Engineered Products Sold with **Service**

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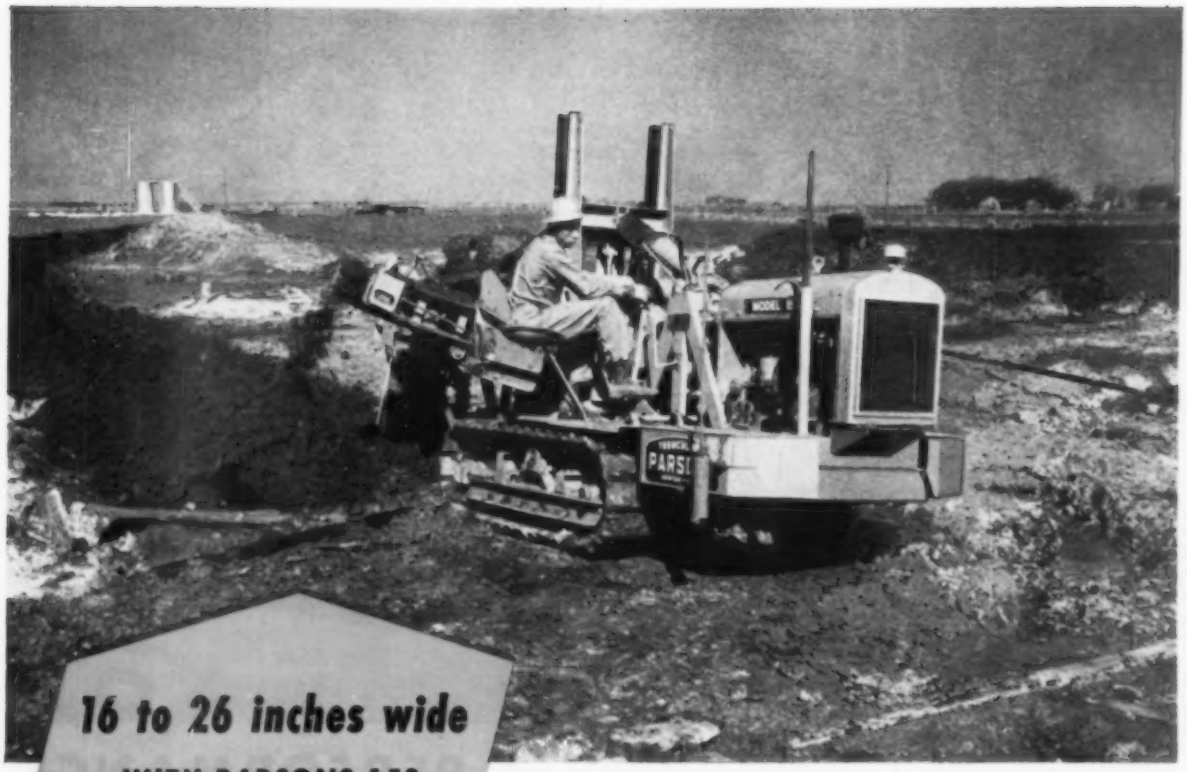


16 to 26 inches wide
WITH PARSONS 150

There is no need to dig and backfill excess yardages on feeder lines, laterals, gathering systems, etc. This medium-size wheel-type Trenchliner fills the bill on secondary lines — and has ample work range to handle a good share of your main-line trenching, too. You get cutting widths from 16 to 26 inches, depths to 5¾ feet with the Parsons 150. **What's more, 30 digging speeds from 12 inches to 25 lineal feet per minute assure maximum production at every depth, width, in all soils.**

You'll also like its precision grading accuracy. A hydraulic ram on vertical mast raises and lowers the digging wheel — gives infinite depth selections, maintains close grade tolerance even in toughest digging. A separate hydraulic ram tilts the mast, balances weight of wheel forward on the 150 Trenchliner when traveling or trailer-loading.

Heavy-duty wheel takes cast-steel buckets with self-sharpening, reversible "Tap-In" teeth, or quick-change gumbo buckets. Shiftable, reversible belt conveyor discharges spoil to either side. 16-inch crawlers, grouser-type shoes, provide plenty of digging traction with low bearing pressure for cross-country work. Let your Parsons distributor tell you more about it, or write for 150 Trenchliner catalog.

PARSONS COMPANY • Newton, Iowa
A division of Koehring Company

31 to 46 in. wide
with MIDDLE-INCH 420

For the big transmission lines, here's a Middle-Inch 420 Trenchliner, with cutting widths of 31 to 46 inches, depths to 7½ feet. Need still more capacity? Then check the Parsons Big-Inch 520, which digs 40 to 52 inches wide, 8½ feet deep. Both "Inchers" are wheel-type ditchers, formerly built by C-R-C. Parsons line also includes ladder-type Trenchliners — all sizes, from a small utility model on rubber tires to big, crawler-mounted models that dig up to 6 feet wide, 19 feet deep.

P786

TRENCHLINERS for PIPELINERS

PROVEN DRAGSHOVEL PERFORMANCE
Now in Popular New Size

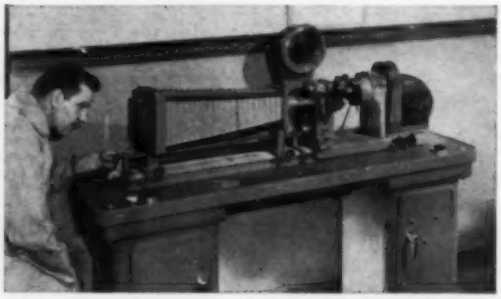
BUCYRUS ERIE

1-yd. 30-B

The outstanding performance of the Bucyrus-Erie 15-B and 22-B dragshovels on pipeline construction now is available in the 1-yard class with introduction of the new 30-B.

The 30-B is available with either diesel or gasoline power, direct or torque converter drive. It features easy air controls; strong, rigid cast-steel revolving frame; large, cool-running clutches and brakes; and optional independent propel. Three widths of trench dippers are available. Side cutters are available for the trench type dippers as extra equipment to give additional cutting widths. Dippers have cast lips fitted with two part teeth. Especially useful to pipeliners whose work often puts them on very rough terrain is a telescopic strut between the auxiliary A-frame and the cab which serves as a safety against kickback when working on steep grades.

Your nearby Bucyrus-Erie distributor will be pleased to give you all the details on this new 1-yd. 30-B dragshovel. Contact him soon.



Bonus Quality—The texture and physical makeup of all metals used in Bucyrus-Erie equipment is an important determinant of their strength and durability. Here a metallographic microscope is being used to check the structure of a sample of metal and photograph it to provide a permanent record. 383E57

BUCYRUS-ERIE COMPANY
SOUTH MILWAUKEE, WISCONSIN

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

These valves will

NEVER NEED "LUBRICATION"

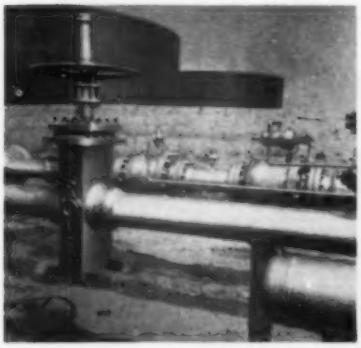
Grove Seal-O-Ring Gate Valves eliminate these costly maintenance and operating problems:

- No lubricants or sealing compounds needed
- No time or labor wasted in lubrication
- No sticking due to loss of lubricant
- No leaking from failure to lubricate
- No damaged gates or seats caused by improper lubrication
- No contamination of product or fouling of adjacent metering or control equipment

The squeegee action of the exclusive *Seal-O-Rings*, which are always in contact with the gate, wipes both sides immaculately clean. This maintains precision factory finish on the sliding surfaces, insuring full freedom of movement – without need for lubricants or sealing compounds. Bearings and stem seals are factory packed for a lifetime of normal service. For 2" to 36" lines – for oil, water, gas – specify *Seal-O-Ring*, the gate valve that's proved it can take care of itself year in and year out.

704

Write for colorful new Pipeline Valve Bulletin No. G-571



GROVE SEAL-"O"-RING Gate Valves

SUBSIDIARY OF WALWORTH

GROVE VALVE and REGULATOR COMPANY • 6529 Hollis St., Oakland 8, Calif.
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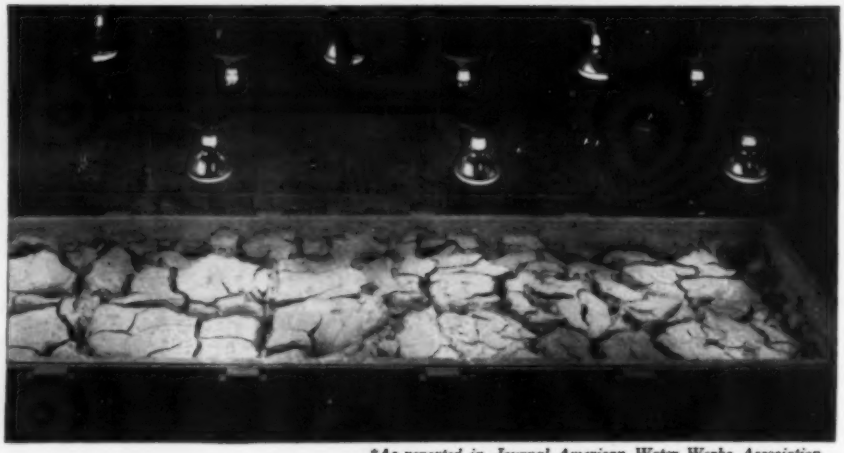
What happens to pipe wrap underground?

Here's what a federal agency found out*...

Many wrap and enamel combinations were imbedded in a test tank filled with bentonite clay slurry. Extreme soil stresses were imposed on these samples by alternate wetting and drying cycles. Resistance to backfill puncture was also checked after each cycle. Holiday-detection tests showed that the glass fiber and coal-tar combination stood up through the full 25 cycles of the test.



*As reported in Journal American Water Works Association, Vol. 48, Feb., 1956. Photo courtesy U.S. Bureau Of Reclamation.

These impartial tests show why BLUE FLAG gives you complete pipeline protection

It was conclusively demonstrated that glass fiber mat like Blue Flag, with coal-tar enamel, provides effective protection against *both* soil-stress and backfill-puncture action. (See picture caption above for actual test conditions.)

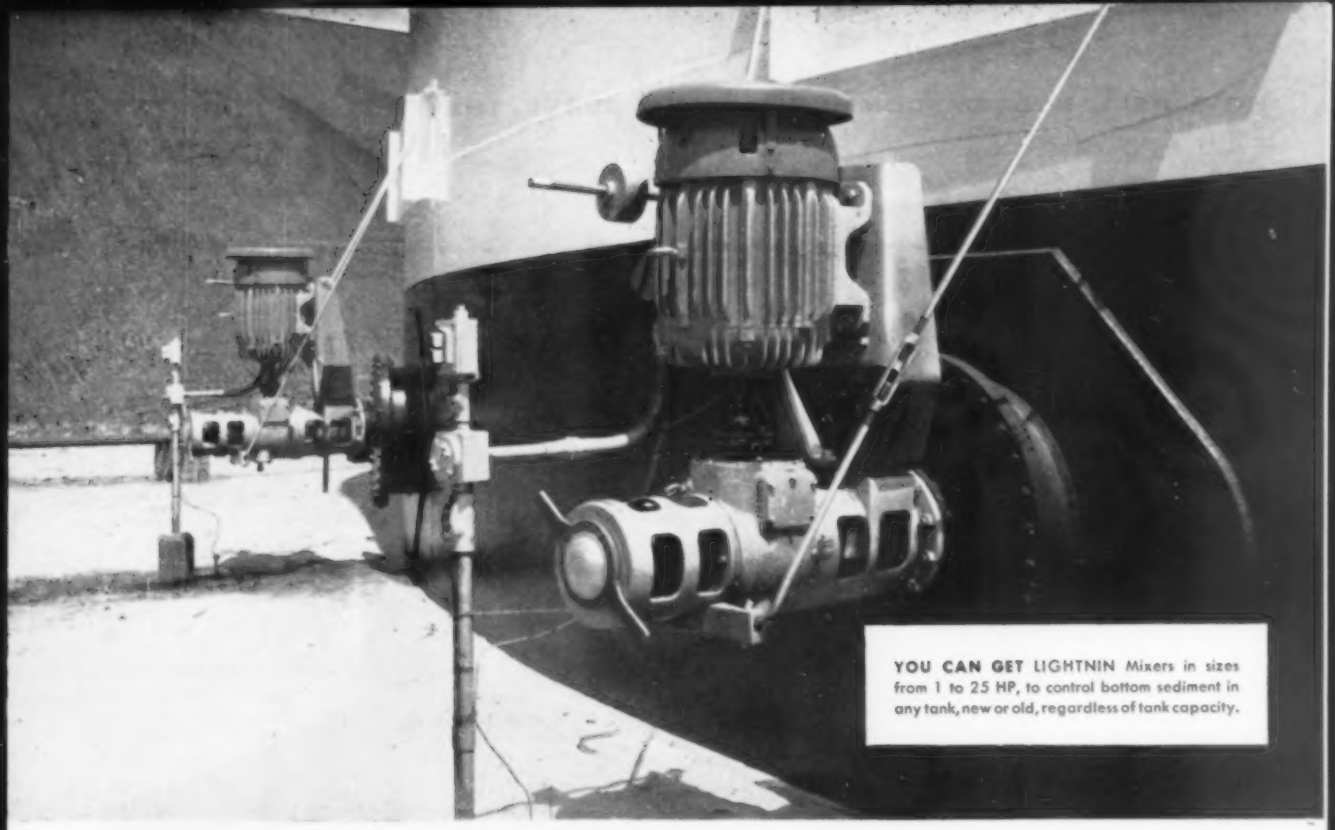
This is the kind of protection you need for maximum service life. Yet it's yours for only ½ of 1% of initial pipeline cost when you use L·O·F Glass Fibers' Blue Flag.

No wonder glass fiber reinforcement like Blue Flag Pipe Wrap is preferred. It strengthens enamel . . . assures coating essentially free of holidays. And, Blue Flag helps speed application—its high tensile strength virtually eliminates breakage in the wrapping operation.

Yard-wrapped, or applied over-the-ditch, Blue Flag can be the answer to your pipeline protection problems. It's available from conveniently located distributor warehouses. For the address of the one nearest you, or for technical information, write: *L·O·F Glass Fibers Company, Dept. 72-107, 1810 Madison Avenue, Toledo 1, Ohio.*

L·O·F GLASS FIBERS

L·O·F GLASS FIBERS COMPANY • TOLEDO 1, OHIO



YOU CAN GET LIGHTNIN Mixers in sizes from 1 to 25 HP, to control bottom sediment in any tank, new or old, regardless of tank capacity.

How to store 10% more crude *without putting up another tank*

Every time you give up an *inch* of tank storage space to settled sludge, you lose many barrels of holding capacity.

Even under normal conditions, your dead storage from accumulated BS&W can run as high as 10% of your total storage capacity.

Get full capacity

You can keep your tanks ready for maximum storage—ready to work at full capacity all the time—with LIGHTNIN Mixers.

An efficient propeller stream turns over the entire tank contents, holds heavy sludge components off the tank bottom, and keeps the crude uniform. You dispatch the *same petroleum values that you receive.*

Cut tank cleaning cost, too

You cut operating costs when you install LIGHTNINS. Careful field tests prove it. Say good-bye to costly, messy sludge cleanout jobs that keep your tanks out of service just when you need them. Instead, you keep your tanks clean by flipping a switch!

How to get started

More than 50 independent pipe line companies, 35 leading oil companies, are using this easy, modern LIGHTNIN way to boost storage capacity, cut costs. How about you? For more facts, just call in your LIGHTNIN Mixer representative (he's listed in Composite Catalog). Or write us today.

Lightnin® Mixers

MIXCO fluid mixing specialists

Get these helpful bulletins on BS&W control and LIGHTNIN Mixers. Check, tear out and mail to us today with your name and company address. Free—no obligation.

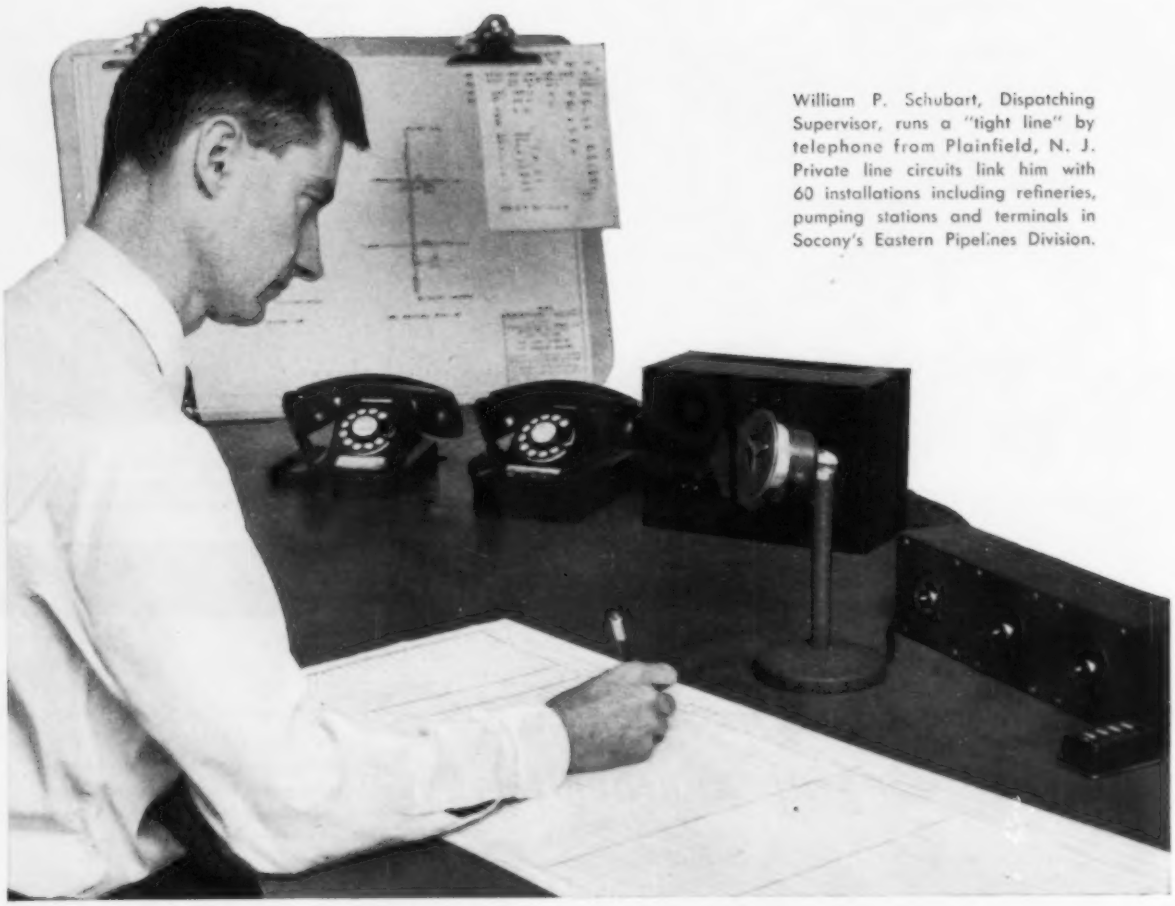
- ☐ BS&W Control with LIGHTNIN Mixers (B-503)
- ☐ Side entering mixers, 1 to 25 HP (B-104)
- ☐ Data sheet for figuring mixer requirements (B-107)
- ☐ Condensed catalog describing LIGHTNIN Mixers—all types (B-109)
- ☐ LIGHTNIN rotary mechanical seals for extra-low-cost mixing (B-111)

MIXING EQUIPMENT Co., Inc., 127-k Mt. Read Blvd., Rochester 11, N.Y.

In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Avenue, Toronto 10, Ont.

DO YOUR TANKS LOOK LIKE THIS? Settled sludge is probably costing you much more than you realize. Cleaning cost is only part of the story.

...OR LIKE THIS? You actually save money when you keep tank bottoms clean this easy way. LIGHTNIN sediment control can save you as much as $1,000 per tank per year.



William P. Schubart, Dispatching Supervisor, runs a "tight line" by telephone from Plainfield, N. J. Private line circuits link him with 60 installations including refineries, pumping stations and terminals in Socony's Eastern Pipelines Division.

He's keeping track of 40 batches by private line telephone service

Using Bell System private line telephone service, the Plainfield, N.J., dispatcher of Socony Mobil Oil Company keeps multi-product traffic flowing through three different pipeline systems. Up to 40 batches of different products are en route at the same time.

The dispatcher relies on the telephone (1) to instruct gaugers at delivery points, (2) to keep all products moving at a proper rate, and (3) to verify the volume of each batch at check points in the line.

Socony Mobil has used Bell System communications for 26 years, has found them dependable and accurate . . . qualities that may well help your own operation. Just call your Bell Telephone Company business office. A representative will gladly study your needs. No obligation, of course.

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FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Frank H. Love
Editor

CONSTRUCTION REPORT: 1957

THE PIPELINE ENGINEER'S annual construction survey reveals statistics that are certainly encouraging, and to some may be a little surprising. This survey covers the last 12-month period and is based on data supplied by pipeline operating companies. Here is what we have found:

- **Lines completed or under construction, 1957 — 25,413 miles**
- **Lines completed or under construction, 1956 — 18,756 miles**
- **Lines planned or proposed, 1957 — 27,689 miles**
- **Lines planned or proposed, 1956 — 23,461 miles.**

Although gas line mileage exceeded by far crude and products lines, as has held true for many years and is to be expected, there was a healthy increase in crude and products pipeline construction. Products pipelines already built or still under construction totaled 6245 miles as compared with 2807 a year ago, more than doubled. Crude oil lines built or under construction totaled 4468 miles, whereas a year ago the figure was 2256 miles, almost doubled in this instance. The current report shows gas pipeline mileage at 14,700 miles as against 13,670 a year ago.

Outlook for the next 12 months is certainly cause for optimism. Our compilation shows 27,689 miles crude, products, and gas pipelines proposed or planned. As we have pointed out in the past, this does not mean that 27,689 miles of pipelines actually will be put in the ground during the course of the next year. Some of the proposals may go by the boards or be postponed. Some of those we have tabulated have been "planned" for several years, but apparently are not dead issues. With such a large mileage planned, however, the industry is certain of a record that will exceed the past 12 months.

Here is the way the 27,689 miles are divided:

13,354 miles of gas lines
8281 miles of crude oil lines
6054 miles of products lines

For matters of comparison the 23,461 miles of pipelines proposed and planned a year ago, were as follows:

15,622 miles of gas lines
4535 miles of crude oil lines
3304 miles of products lines

Gas Pipeline Construction

In some respects, but not all, Canada took the spotlight away from the United States with its two big lines, Trans-Canada and Westcoast Transmission.

The final stage of the Westcoast Transmission Company project, 650 miles from Taylor, British Columbia, to Sumas, Washington, was completed this fall, ahead of schedule. This line originates in the Peace River area of Alberta, serves communities along the route, and delivers gas to the Pacific Northwest Pipeline system at Sumas. Overall, including main line, laterals, and gathering lines, the system totals 1472 miles, and was the first major gas line to be constructed in Canada.

Trans-Canada is building what will be the world's longest gas line when completed. The system originates in Alberta and will extend to eastern Canada, a distance of 2250 miles. Already gas is being delivered as far as Winnipeg, a distance of 585 miles, but the entire project is not expected to be completed until the latter part of 1958.

In the United States, a history-making event was completion of a line by Texas Eastern Pipe Line Corporation to import gas from Mexico. This is the first major importation of gas from that country. The line extends from the international border below McAllen, Texas, to Texas Eastern's Vidor station near Beaumont, Texas. Gas is processed at the Pemex natural gasoline at Reynosa and delivered to the Texas Eastern system at the border.

Additionally, the company has under construction or planned 979 miles of loops to its gas system.

Natural Gas Pipeline Company of America has a project underway that, although not especially extensive insofar as mileage is concerned, is of considerable interest because it provides an outlet for more than a hundred shut-in wells in Jack and Wise counties Texas. The line is 350 miles long and extends from near Bridgeport, Texas, northward through Oklahoma, and west in the Texas Panhandle to tie-into the company's main line at Fritch.

Southern California Gas Company and Southern Counties Gas Company on August 28 dedicated the Needles-to-Newhall-to-Alhambra 30-in. line to bring more out-of-state gas into the southern California area. Initial capacity is 227,600,000 cu ft a day, which will be increased later, with the gas coming from Texas, New Mexico, and Arizona.

El Paso Natural Gas Company, continuing its expansion program of many years, has completed 1023 miles of pipeline during the last 12 months, and has an immediate program planned for 600 miles more. Expansions have been to its San Juan and Permian Basin systems to provide additional gas for shipment to California.

Tennessee Gas Transmission Company has completed 353 miles of loops to its system and now has underway a 107-mile project from Kinder, Louisiana, that will extend into the Gulf of Mexico to bring gas from offshore wells. Applications are pending before the Federal Power Commission for 632 miles of new lines and 264 miles of loops.

Transcontinental Gas Pipe Line Corporation has completed, or is nearing completion, 744 miles of loops and laterals, and has immediate plans for 87 miles of 24-in. in Louisiana.

The proposed gas line from South Texas to Miami, Florida, has hit a temporary snag. A group of 119 fuel oil dealers, under the original name Florida Economic Advisory Council, is attempting to have the Federal Power Commission's approval withdrawn. The case must be heard by the circuit court of appeals in Washington, D. C., before construction can begin. Coastal Transmission Corporation would build the line from McAllen, Texas, to Baton Rouge, Louisiana, and Houston Texas Gas and Oil Company from that point to Miami.

Crude Oil Lines

Crude oil pipeline construction shows a healthy condition, with 4468 miles completed or under construction and 8281 miles planned as of this report, which compares with 2256 miles completed or under construction and 4535 miles planned a year ago.

The rapid development of the Four Corners area has been a big boost to crude pipeline construction. Another factor has been expansion of certain lines to move Permian Basin crude to the Gulf Coast.

Four Corners Pipe Line Company is making good progress on its system from the Four Corners area of New Mexico, Colorado, Utah, and Arizona, to refineries near Los Angeles, which will give that fast growing producing area its first pipeline outlet. Crude is now being transported by tank car and tank truck, but this method cannot take care of the full production and the situation is becoming worse as more wells are brought in.

The main line is of 16 in. pipe, with a 12-in. line out of the Bisti field of New Mexico, and 6, 8, and 10-in. feeder lines connecting various other fields in Utah and New Mexico.

Four Corners Pipe Line is jointly owned by Shell Oil Company, Continental Pipe Line Company, Gulf Oil Corporation, Richfield Oil Corporation, Standard Oil Company of California, and Superior Oil Company. Construction of the line is under supervision of Shell Pipe Line as agent for the owners and that company also will operate the system.

Texas-New Mexico Pipe Line Company will give the Four Corners area its second crude oil outlet. First contracts were recently let and right-of-way grading is underway with pipe laying scheduled to begin about October 15. This line will be of 16-in. pipe and will extend 515 miles from the Aneth field, southeast Utah, to Jal, New Mexico, where it will connect with the company's existing system.

Completed this fall was the Tecumseh Pipe Line Company system from Schererville, Indiana, to Cygnet, Ohio. This 201-mile, 20-in. line is owned by Sinclair, Pure, and Ashland, and connects with the Buckeye system for delivery to points north, south, and east.

The Suez crisis pointed up the fact that there was insufficient pipeline capacity from the Permian Basin area to the Gulf Coast where crude could be loaded into tankers for shipment overseas. One pipeline company to do something about it is Magnolia, which is increasing capacity by looping between Midland and Beaumont. More than 200 miles of pipe is involved.

Great interest is evidenced in a recent announcement that agreement had been reached between the Iranian and Turkish governments whereby the former will build a 38-in., 1000-mile pipeline from the Qum area of Iran to Iskenderun, Turkey. Early in the year 17 American, British, French, and Dutch companies had entered into consultation with a view to laying a line that would serve the same purpose of moving Middle East crude to a Mediterranean port in Turkey. This line was announced as a 38 or 40-in. system 1500 miles in length. It is not likely that both lines will be built. Consequently, although we have listed both systems in following tables, we have not added both to the total mileage of proposed or planned pipelines.

Another foreign crude oil line just announced is by the Argentine Government (YPF), a 640-mile line from the Campo Duran fields on the Bolivian border to a refinery at Rosario. A part of the same announcement was a 815-mile gas line from Campo Duran fields to Buenos Aires.

Products Pipelines

LPG pipeline construction had one of its biggest years. Gulf, Interstate, Magnolia, and Texaco-Cities Service were among the largest LPG pipeline builders. Gulf converted a 461-mile crude oil line between Lufkin and Midland, Texas, to LPG service, but also constructed new lines between Mont Belvieu and Lufkin, North Snyder and Coahoma, Monument, New Mexico, and Midland, and Waddell and Midland. In all, Gulf placed in service 760 miles of LPG lines during 1957.

Interstate Oil Pipe Line laid a total of 152 miles of 4, 6, and 8-in. LPG pipeline from the Esso refinery at Baton Rouge, Louisiana, to Sorrento Salt Dome, Louisiana. The unusual part of this project was the fact that four lines were laid in the same ditch, the distance between the two points being only 38 miles.

During the last 12 months Magnolia Pipe Line has built 206 miles of LPG lines, principally in the West Texas and Gulf Coast areas.

Texaco-Cities completed an LPG line, 168 miles of 6-in., between East Chicago, Indiana, and Lowell, Michigan.

Leading the field in refined products pipelines during the last year were Great Lakes Pipe Line Company and Southern Pacific Pipe Lines, Inc. Great Lakes has made additions to its system all the way from Kansas and Oklahoma into Iowa, Nebraska, Illinois, Wisconsin, and Minnesota. In all, 402.6 miles of 6, 8, and 12-in. pipe has been laid.

Southern Pacific, which originally built a pipeline from Los Angeles to Phoenix, Arizona, to El Paso, Texas, has added to its system with a line from Richmond, California, to Fallon, Nevada. This work has just been completed and consists of 311 miles of 6, 8, and 10-in. Not yet begun, but planned, is a 35-mile 4 and 6-in. line from Niland to El Centro, California.

Reconversion of the Little Big Inch pipelines has been accomplished. Permission of FPC for return of this line to service for which it was originally built was withheld for several years due to opposition of large interests. In addition to reconditioning and equipping with pumps and prime movers required for pumping products, 230 miles of new 14-in. pipeline was installed between Seymour, Indiana, and Chicago, Illinois.

Plantation Pipe Line late last year completed the looping of its system from Baton Rouge, Louisiana, to Helena, Alabama, with 327 miles of 18-in.

Ohio Oil Company is looking ahead to 1958 when it expects to construct 250 miles of 12-in. between Hartford, Illinois, and Griffith, Indiana.

In the East, Underground Storage and Exploration, Inc., has been organized and a part of the project is the construction of 393 miles of 6, 8, and 12-in. products pipeline from Moundsville, West Virginia, to Newark, New Jersey, with laterals to Mauch Chunk, Marcus Hook, and Philadelphia. Products are expected to be received from the Little Big Inch or Paul Ryan's American Pipe Line, it was announced. The American project has been somewhat dormant but apparently is not a dead issue. The same can be said of Hydrocarbons Pipelines, Ltd., of Winnipeg, Canada, which more than a year ago announced plans for an 800-mile, 6 and 8-in. pipeline between Edmonton and Fort William.

A complete tabulation of pipelines "Proposed or Planned" and "Built or Underway" is given in the following tables.

Proposed or Planned Pipelines

The following tables list the company, mileage, pipe size, and location of proposed pipeline projects — crude, products, and natural gas — reported to *The Pipeline Engineer*. Company addresses are given when known.

CRUDE LINES

Name of Company	Miles	Size	Location
Act Oils Toronto, Ontario, Canada	350		Line from Peace River area in British Columbia, thru Pine Pass to Prince George, westward to Bella Coola terminus on Pacific Coast
Argentine Government (YPF) Buenos Aires, Argentina	640	12	Campo Duran fields to Rosario
Atlantic-Cities-Service-Continental-Gulf-Phillips-Texas-Sinclair	Approx. 385	26	Midland, Texas, area to Houston
B-A Alberta Pipe Line, Ltd. Calgary, Alberta, Canada	35	8	Drumheller field, Alberta, to Edmonton line
Belle Fourche Pipeline Co.	30	6	Donkey Creek to Fiddler Creek, Wyoming
Bolivian Gulf Oil Corp. La Paz, Bolivia	202	8, 10	Sicascia to Africa
Cape Pipe Line Company Philadelphia, Pennsylvania	200		Large diameter from Delaware Bay to Greater Philadelphia area refineries
Creole Petroleum Corp. Caracas, Venezuela	86	30	Temblador field to Caripito, Venezuela
Forest Pipeline Company	33	8	Trieve field to Casper, Wyoming
Great Northern Railway Co. St. Paul, Minnesota	800		Williston Basin to St. Paul-Duluth-Superior, Wisconsin-Minnesota area
Iran Government	1000	38	Qum, Iran, to Iskenderun, Turkey
Iraq Petroleum Co. London, England	Approx. 600		Kirkuk field to Iskenderun, Turkey
Magnolia Pipe Line Company Dallas, Texas	23.67 20.07 82.73 4.77	20 12¾ 16 12¾	Loop from Corsicana, Texas to Clyde, Texas Loop from Corsicana, Texas to Clyde, Texas Loop from Corsicana, Texas to Clyde, Texas Loop from Midland, Texas to Clyde, Texas
Mene Grande Oil Co. Caracas, Venezuela	45	24	Oficina to Melones, Venezuela
Mid-Continent Pipe Line Company Tulsa, Oklahoma	6 4.5	6 10	Maysville station to Criner area Enlargement from Eola station to Maysville station, Oklahoma
Musgrove Petroleum Co. Wichita, Kansas	180		Hugoton field, Kansas, to Raymond, Kansas
North-West Oil Pipelines Company	210		Wilhelmshaven, on the North Sea, to industrial Ruhr area of West Germany
Northwest Pipe Line Corporation Salt Lake City, Utah	350	8–10	Four Corners area to Salt Lake City, Utah
Offshore Gathering Company Houston, Texas	364	20	Gulf of Mexico from Sabine Pass to Mississippi River
Oil Field Pipe Line, Inc. Wichita, Kansas	180	8	To extend northeast from Hugoton field, Kansas, to Raymond, Kansas tie-in with Arapahoe Pipe Line system
Oil Field Pipe Line, Inc. and Panhandle Eastern Pipe Line Co. Kansas City, Missouri	200	8, 12	Elkhart to Ellinwood, Kansas
Royal Dutch Shell Group and Others The Hague, Netherlands	870	30	Marseille, France, to Rotterdam, Holland, and Antwerp, Belgium
Royal Pipe Lines, Ltd. Regina, Saskatchewan, Canada	288	Var.	Cantuar area fields to Glenavon
Seventeen American, British, French and Dutch companies	450	38–40	Likely route to run from head of Persian Gulf, through Iraq and Turkey to Turkish coast on the Mediterranean Sea
Shell Pipe Line Corporation Houston, Texas	5.5	4–6	Replacement East Texas gathering lines
Sinclair Pipe Line Company Independence, Kansas	150	20	Teague to Houston, Texas
Sohio Pipe Line Company St. Louis, Missouri	5	6	Avena, Illinois
Southern Kansas Pipe Line Company	310	6, 10	10,000 bbl per day line from Greenwood pool, near Colorado line, thru Liberal to Arkansas City, Kansas
Trans-Border Pipe Line Company	110		Skagway, Alaska, to Whitehorse, Yukon Territory
Trans-Prairie Pipelines, Ltd. Edmonton, Alberta, Canada	6.88	4, 3	Gathering lines, Virden Roselea field
Westspur Pipe Line Co. Toronto, Canada	20 34	12 4–6	Alida, Saskatchewan to Carnduff-Glen Ewen area Gathering lines in Cantal, Hastings, Florence, Carnduff, and Glen Ewen fields
17 American, English, French and Dutch companies	1500	38–40	Middle East producing areas to Mediterranean coast in Turkey

PRODUCT LINES

Name of Company	Miles	Size	Location
American Pipe Line Co. New York, New York	1910	8–26	Beaumont, Texas to Newark, New Jersey
Buckeye Pipe Line Company New York, New York	70	8	Wayne to Durand, Michigan, common carrier
Cherokee Pipe Line Company Ponca City, Oklahoma	12	12	Tulsa to Glenpool, Oklahoma
Equitable Gas Company and Subsidiaries Pittsburgh, Pennsylvania	100	4–5	Maytown, Kentucky, to Institute, West Virginia
Everglades Pipe Line Company Everglades, Florida	60	10	Pt. Everglades to Miami, Florida
Hydrocarbons Pipelines, Ltd. Winnipeg, Manitoba, Canada	800	6–8	Edmonton, Alberta, to Fort William, Ontario
Interstate Oil Pipe Line Company Shreveport, Louisiana	17	4	Esso Baton Rouge Refinery to Dow plant terminal, Plaquemine, La
Laurel Pipe Line Company Pittsburgh, Pennsylvania	350	14–24	Philadelphia to Pittsburgh to Cleveland
Leonard Refineries, Inc. Alma, Michigan	43	6	Alma to Lansing, Michigan
Mene Grande Oil Co. Caracas, Venezuela	60	6	Anaco to Puerto La Cruz, Venezuela
Northwest Pipeline Corporation Salt Lake City, Utah	350	8–10	Four Corners to Salt Lake City, Utah
Ohio Oil Company Findlay, Ohio	250	12	Hartford, Illinois to Griffith, Indiana
Phillips Chemical Company Bartlesville, Oklahoma	28	4	Pasadena to Texas City, Texas
Service-Continental-Sinclair-Phillips	550		Salt Lake City, Utah to Spokane, Washington
Southern Pacific Pipe Lines, Inc. Los Angeles, California	35.7	6, 4	Niland to El Centro, California
Underground Storage and Exploration, Inc.	393	6, 8, 12	Moundsville, West Virginia, to Newark, New Jersey, with laterals to Mauch Chunk, Marcus Hook, and Philadelphia
Union Oil Company of California Los Angeles, California	815		Shale Oil Plant, Rifle, Colorado to Los Angeles area
Winnipeg & Central Gas Company Winnipeg, Manitoba, Canada	210	6	U.S. Canadian border to Winnipeg

GAS LINES

Name of Company	Miles	Size	Location
Alberta Gas Trunkline Company, Ltd.	65	34	Extension, Alberta, Canada
Calgary, Alberta, Canada	150	24	To Pincher Creek field, Alberta, Canada
	25	26	To Steveville and Cessford fields, Alberta, Canada
	10	6	To Sibbald field, Alberta, Canada
	112	22	To Nevis and Sunnynook fields, Alberta, Canada
	52	16	To Homeglen-Rimbey field, Alberta, Canada
	35	6–10	To various fields
Andes Pipeline Corporation	500	12	Villamontes, Bolivia to Antofagasta, Chili
Argentine Government (YPF) Buenos Aires, Argentina	815		Campo Duran fields to Buenos Aires
Arizona Public Service Company	3.25	10	Loop between Phoenix and Tempe, Arizona
Phoenix, Arizona	11	10, 4	Phoenix to Deer Valley, Arizona
Arkansas Louisiana Gas Company Shreveport, Louisiana	300		Main and gathering lines Louisiana-Texas Gulf Coast
Bee County Gathering System Corpus Christi, Texas	45		Bee County, Texas, gathering lines
Cities Service Gas Company	6.59	30	Replacement from Merriam to Kansas City, Kansas
Oklahoma City, Oklahoma	78.20	30	Replacement from Independence to Welda, Kansas
	6	12	Replacement, Hutchinson, Kansas
	16.15	26	Replacement, Independence to Elk City, Kansas
	10	20	Replacement, Ottawa, Kansas
Cities Service Oil Company Bartlesville, Oklahoma	70		Gas gathering system on the Roberts Ranch, Midland, Texas
Coastal States Gas Purchasing Co. Corpus Christi, Texas	21		Gathering system in Rock Island area, Colorado County, Texas
Coastal Transmission Corporation	574	22–26	McAllen, Texas to Baton Rouge, Louisiana
Dallas, Texas	414	Var.	Gathering lines in Rio Grande Valley, Texas
Colorado Interstate Gas Company	8	24	Bivens to Fourway, Texas
Colorado Springs, Colorado	190	26	Loop from Fourway, Texas to Greenwood take-off, Baca County, Colo.
	40	34	Loop from Greenwood take-off, Baca County, Colorado to Springfield, Colorado station
	100	24	Springfield, Colorado, station to Pueblo, Colorado
	66	30	Loop from Springfield, Colorado, station to Kit Carson, Colo. station
	345	30	Kit Carson, Colorado, station to Beatrice, Nebraska
	8.2	16	Keyes field to Keyes station
	22	6	Trinidad, Colorado, to Raton, New Mexico
	1.9	16	Replacement from Bivins main line to Pueblo, Colorado
	28.5	4–10	Replacement, Panhandle field, Texas

GAS LINES

Name of Company	Miles	Size	Location
	7.8	4–8	Panhandle field, Texas
	7.4	4	Greenwood field, Kansas
	12	6–20	Replacement, Greenwood field, Kansas
	5	4	Hugoton field, Kansas
	1.5	4	Sparks field, Kansas
	46	4–6	Mocane field, Oklahoma
	27.9	4–10	Laverne field, Oklahoma
Cuban Gas Transmission Company (Edwin Pawley) Los Angeles, California	1000		Mexico to Florida via Cuba
Eastern Shore Natural Gas Company Salisbury, Maryland	124	6, 8	Transmission line and facilities in Delaware and Maryland
Edison Securities Company Los Angeles, California	130		San Joaquin Valley to Los Angeles
El Paso Natural Gas Company El Paso, Texas	10	30	Loop of Roswell discharge
	14	26	Second loop west of Gila
	74	10¾	Loop from California system to Yuma
	176.8	20	Sonora plant to Plains plant
	8.5	16	Kutz-Angeles Peak to Chaco
	0.5	16	Loop of Jal No. 3 discharge
	18.1	12¾	Good plant to Vealmoor plant
	11.4	12¾	Kutz plant to 16-in. Chaco line
	8.7	10¾	Angeles Peak to 16-in. Chaco line
	20.5	34	Loops on San Juan main line
	67.2	30	Loops on Permian-San Juan line
	13.8	26	Second loop west of Gila
	26.0	6⅝	San Manuel to Hayden, Arizona
	4.0	8⅝	Loop from Gulf Waddell to Upton County line
	5.8	8⅝	Sun Oil to Jameson
	125.6	30	Loops on Permian-San Juan line
	14.1	30	Loop South System west of Keystone
Equitable Gas Company Pittsburgh, Pennsylvania	7.0	16	Franklin and Whiteley, Greene County, Pennsylvania
	2.2	6, 8, 12	Courthouse and Collins Settlement districts, Lewis County, West Virginia
Houston Texas Gas & Oil Company Houston, Texas	942.6	12–30	Baton Rouge, Louisiana to Miami, Florida
	682		Laterals to serve Florida distributors and industrial users
Iron Ranges Natural Gas Co. St. Paul, Minnesota	115		In Mesabi Iron Range area
Michigan Wisconsin Pipe Line Company Detroit, Michigan	3.7	12	Lateral, Wisconsin
	13.8	6	Loop line in Michigan
	0.6	4	Lateral, Missouri
	65.3	16	Lateral, Wisconsin
	32.1	16	Loop line in Wisconsin
	48.0	12	Lateral, Wisconsin
	16.8	12	Loop line, Wisconsin
	253.7	10	Lateral, Wisconsin
	61.2	8	Lateral, Wisconsin
	43.4	6	Lateral, Wisconsin
	26.9	24	Loop line in Illinois
	34.6	24	Loop line in Indiana
	38.0	24	Loop line in Michigan
Midwestern Gas Transmission Company Houston, Texas	2067	3–24	Main line from U.S. Canadian border near Emerson, Manitoba—Noyes, Minnesota, to Portland, Tennessee Laterals off mainline to serve communities in Minnesota, North Dakota, and Wisconsin
Natural Gas Pipeline Company of America Chicago, Illinois	416	36	Loop from Beatrice, Nebraska to Joliet, Illinois
	337	30	Loop from Fritch, Texas to Beatrice, Nebraska
New York State Natural Gas Corporation Pittsburgh, Pennsylvania	9.5	12¾	Stockbridge to Oneida, New York
Niagara Mohawk Power Corp. Syracuse, New York	196	2–16	Central, eastern, and northern New York
North Caroline Natural Gas Corp. Houston, Texas	625	2–16	Intrastate line in North Carolina
Northern Natural Gas Company Omaha, Nebraska	28	24	Ogden to Redfield storage area, Iowa
	168	20	Farmington, Minnesota to Duluth, Minnesota, and Superior, Wisconsin
	100	20–24	Savannah Creek field, Alberta, to Alberta-Montana border near Cardston, Alberta
	20.8	30	Loop north of Sunray, Texas
	13.0	30	Loop north of Beaver, Oklahoma
	10.5	30	Loop north of Macksville, Kansas
	7.1	30	Loop north of Tescott, Kansas
	9.1	30	Loop north of Clifton, Kansas
	8.9	30	Loop north of Palmyra, Nebraska
	8.0	24	Loop north of Hooper, Nebraska
	7.6	24	Loop north of Sioux City, Iowa
	8	30	Loop north of Bushton, Kansas
	9	30	Loop north of Beatrice, Nebraska
	8.3	30	Loop north of Oakland, Iowa
	17.2	30	Loop north of Ventura, Iowa
	11.1	24	Loop north of Paullina, Iowa
	44	16	Duluth-Superior to Iron Ranges
	1090	2–16	Branch lines to serve 213 new communities

GAS LINES

Name of Company	Miles	Size	Location
Northern Plains Natural Gas Company (subsidiary of Northern Natural Gas Company) Omaha, Nebraska	1100	26	Alberta-Montana border to Minneapolis, Minnesota
Offshore Gathering Company Houston, Texas	364	30	Offshore gas line in Gulf of Mexico from Sabine Pass to Mississippi River
Oklahoma Natural Gas Company Tulsa, Oklahoma	21	12	Replacement, Sec. 12-3S-3W to Sec. 25-4S-1E
	3	8	Replacement from Sec. 2-15N-15E to Sec. 22-15N-15E
	3	6	Replacement from Sec. 20-4S-3E to Sec. 22-4S-3E
	7.5	4	Replacement from Sec. 32-4S-2W to Sec. 30-4S-3W
	6.5	8	New line from Sec. 14-11N-12E to Sec. 17-10N-13E
Pacific Gas & Electric Company San Francisco, California	1300	36	Alberta, Canada, gas fields to Antioch, California
Pennsylvania Gas Co. Warren, Pennsylvania	23	10	Erie County, Pennsylvania
	15	8	Warren and Chautauqua Counties, Pennsylvania
	30	Var.	Lateral and distribution lines
Permian Basin Pipeline Company Omaha, Nebraska	83	16	Interconnection from proposed Pioneer's gathering system to Permian's facilities at Spraberry, Texas
	28.8	10	From Crane and Pecos counties, Texas to McCamey, Texas
Petroleos Mexicanos Mexico City, Mexico	130	22	Reynosa to Monterrey
Piedmont Gas Co. Hickory, North Carolina	78	2–8	In Gaston, Lincoln, Catawba, Caldwell, and Burke counties, N. Carolina
Pioneer Gathering System, Inc. Amarillo, Texas	4.6	12	Schleicher County, Texas
	30	6	Schleicher County, Texas
	15	Var.	Sutton and Val Verde Counties, Texas
Pioneer Natural Gas Company Amarillo, Texas	38	16, 10¾	Replacement, South Plains of West Texas
	28	6⅝	South Plains of West Texas
	50	Var.	South Plains and Permian Basin, Texas
Southern California Gas Co. Southern Counties Gas Co. Los Angeles, California	83	34	From Coles Levee to Newhall
Southern Natural Gas Company Birmingham, Alabama	5.0	6⅝	Eloi Bay to Block 69 in Louisiana
	10.0	6⅝	Pt. Comfort to Block 69 in Louisiana
	16.8	6⅝	Block 69 to Breton Island in Louisiana
	3.5	12¾	Block 46 to Block 47 in Louisiana
	3.0	12¾	Block 47 to Block 48 in Louisiana
	4.5	12¾	Block 48 to Olga receiving station
	46.0	20	So. Sec. 28 field to White Castle Compressor Station
	6.5	10¾	Bayou Bouillion field to White Castle — So. Sec. 28 line, Louisiana
	11.5	8⅝	Bayou Bouillion field to East Happytown field, Louisiana
	19	10¾-8⅝	Loisel field to White Castle-So. Sec. 28 line, Louisiana
	16.2	20	Lake Washington field to east leg, South Louisiana supply line
	3.0	12¾	Mississippi River crossing
	21.5	12¾	Lake Washington field to West Delta Block 30 field, Louisiana
	4.2	8⅝	Bayou Long field to west leg South Louisiana supply line, Louisiana
	5.6	4½	Bayou Villars to Barataria line, Louisiana
	11.6	6⅝	Marrero field to Barataria line, Louisiana
	6.4	6⅝	South Lake Long field to Montegut field, Louisiana
	0.5	4½	Tigers Ridge field to Barataria line, Louisiana
	34.7	16	Montegut field to Lake Enfermer line, Louisiana
	13.2	16	Junction Barataria and Lake Enfermer lines to east leg of South Louisiana supply line, Louisiana
	3.0	12¾	Loop, Mississippi River crossing
	69.4	24	Loop from Toca and Franklinton compressor station to east leg south Louisiana supply line, Louisiana
	67.4	26	Loop from Franklinton to Gwinville, Louisiana and Mississippi
Tennessee Gas Transmission Company Houston, Texas	556	30	South of New Orleans to Portland, Tennessee
	76	24	Coudersport, Pennsylvania to Hamburg, New York
	163	30	Loop from Portland, Tennessee and Winchester, Kentucky to Lancaster and Morehead, Kentucky
	39	26	Loop from Catlettsburg, Kentucky to Broad Run, West Virginia
	12	26	Loop south of Mercer, Pennsylvania
	50	26	Loop from Morehead, Kentucky to Catlettsburg, Kentucky
Texas Eastern Penn-Jersey Corporation Shreveport, Louisiana	65	30	Loop from Delmont, Pennsylvania, to Lambertville, New Jersey
Texas Eastern Transmission Corporation Shreveport, Louisiana	105	30	Loop from Vidor, Texas to Kosciusko, Mississippi
	140	30	Loop from Kosciusko, Mississippi, to Uniontown, Pennsylvania
	22	14	New line, Rayne 30-in. line
Trans-Canada Pipe Lines, Ltd. Calgary, Alberta, Canada	492	30	New line from Kapuskasing, Ontario, to Sheridan, Ontario, Canada
	48	24	New line from Winnipeg, Manitoba to Emerson, Manitoba, Canada
Transcontinental Gas Pipe Line Corporation Houston, Texas	65	24	St. Helena Parish, Louisiana, on Louisiana-Mississippi border south to Mississippi River
			Multiple crossing of Mississippi River at Convent, Louisiana
	22	24	South from Mississippi River
Trans-Western Pipe Line Company Los Angeles, California	725		Four Corners area to point in California

Lines Built or Underway

The following tables list details on crude, products, and gas lines built or under construction in the 12-month period ending October 1, 1957, as reported to *The Pipeline Engineer*.

CRUDE LINES

Name of Company	Miles	Size	Location	Date Completed
Arapahoe Pipe Line Co. Chicago, Illinois	21.7	3, 4, 6	Gathering lines to Kansas, Colo., Nebr.	8/57
Buckeye Pipe Line Co. New York, N. Y.	1.6	12	Loop from Mantua, Ohio to Warren, Ohio	7/57
Burmah Oil Company Glasgow, Scotland	853	20	Nahorkatiya to Calcutta, India	UC
California Company New Orleans, La.	10	6	Offshore in West Delta, Louisiana area	1956
Caminol Company	15	4	Coalinga Nose field to Kettleman City, California	1956
CATC (Continental, Atlantic, Tidewater, Cities Service) Ponca City, Oklahoma	25	6, 8, 12	Offshore from Grand Isle, Louisiana	10/57
Cooperative Refinery Association Kansas City, Missouri	6	6	Replacement from Stockton, to Phillipsburg, Kansas	7/57
Forest Pipeline Corporation	35	8	Grieve field, Wyoming, to Casper, Wyoming	UC
Four Corners Pipe Line Co. Houston, Texas	755.4	4–16	Four Corners Area to Los Angeles, California	UC
Gulf Refining Co. Houston, Texas	44.3	10	Loop from Crane, to Midland, Texas	3/57
Humble Pipe Line Co. Houston, Texas	94	18	Ector to Kemper, Texas	2/57
	7.7	10	Viola to Corpus Christi, Texas	UC
	100		Gathering lines in various fields	UC
Interprovincial Pipe Line Company Toronto, Ontario, Canada	155.9	20	Sarnia to Port Credit, Ontario	8/57
	32.6	24	Loop from Kendal to Peebles, Saskatchewan	8/57
Kaw Pipe Line Company Tulsa, Oklahoma	12	8	Sullivan station to Victoria, Kansas	9/57
Lakehead Pipe Line Co., Inc. Toronto, Ontario, Canada	34.4	26	Loop from Clearbrook to Rosby, Minnesota	8/57
	25.7	26	Loop from Deer River to Worba, Minnesota	8/57
	18.2	26	Loop from Wrenshall, Minnesota to Superior, Wisconsin	8/57
Interstate Oil Pipe Line Co. Shreveport, Louisiana	16.70	12	Pelican Island to Jct. on Sec. 97 Lake Washington, Louisiana	12/56
Magnolia Pipe Line Co. Dallas, Texas	36.0	12¾	Andrews to Midland, Texas	11/56
	8.0	20	Replacement from Maumelle Lake to Little Rock, Arkansas	7/57
	29.0	8⅝	Seminole to Andrews, Texas	3/57
Mene Grande Oil Co. Caracas, Venezuela	97	30	Eastern Venezuela to Puerto La Cruz	UC
Mid-Continent Pipe Line Co. Tulsa, Oklahoma	3.0	6	Enlargement from Lindsey station to Maysville, Oklahoma	10/56
	3.0	6	Enlargement from Hominy station to East Osage, Oklahoma	11/56
	1.0	5	Loop from Mt. Vernon pool to Key West station	3/57
	1.0	6	Enlargement from Bristow to Beggs, Oklahoma	3/57
	3.5	6	Replacement from Little Farm station to Drumright, Oklahoma	5/57
	2.5	5	Loop from Yale station to Drumright, Oklahoma	7/57
	2.0	6	Bristow station to Beggs, Oklahoma	8/57
Muskegon Pipe Line Corp. Muskegon, Michigan	164	10	Griffith, Indiana to Muskegon, Michigan	UC
New York Transit Co., Inc. New York, N.Y.	4	8	Loop from Olean to Lonesome Hollow, New York	8/57
Northern Pipe Line Co. New York, N.Y.	4	12	Loop from Simpson to Bear Creek, Pennsylvania	7/57
Pasotex Pipe Line Co. El Paso, Texas	13	4, 6	Iraan, Texas to Sheffield field	2/57
	75	20	Replacement from Wink to El Paso, Texas	5/57
	52	20	Replacement from Wink to El Paso, Texas	9/57
Pembina Pipe Line, Ltd. Calgary, Alberta, Canada	32	16	Loop from Calmar to Edmonton	6/57
	85	3, 4, 6	Gathering lines in Pembina field	UC
Phillips Pipe Line Co. Bartlesville, Oklahoma	14	8, 10	New line in West Texas	11/56
Rangeland Pipe Line Co., Ltd. Calgary, Alberta, Canada	46.5	12	Sundre field, Alberta, to Gilbey West field	1957
Salt Lake Pipe Line Co. Salt Lake City, Utah	90	10	Loop from Rangely, Colorado to Salt Lake City, Utah	UC
Sinclair Pipe Line Co. Independence, Kansas	35	4, 6, 8	Palestine to Slocum, Texas	8/57
Skelly Oil Co. Tulsa, Oklahoma	9	6⅝	Gathering and trunk lines in central and southwestern Kansas	8/57
	39	8⅝	Gathering and trunk lines in central and southwestern Kansas	10/57
	51	12¾	Gathering and trunk lines in central and southwestern Kansas	UC
	12	6⅝	Gathering and trunk lines in central and southwestern Kansas	UC
Socony Mobile Oil Co., Inc. New York, N.Y.	211	20	Silvestre to El Palito, Venezuela	9/57
South Saskatchewan Pipe Line Co. Regina, Saskatchewan, Canada	59	12	Cantuar to Pollard, Saskatchewan	10/56
Suntide Pipe Line Co. Corpus Christi, Texas	40	8	Refugio to Pettus, Texas	1956
Tecumseh Pipe Line Co. Independence, Kansas	201	20	East Chicago, Indiana to Cygnet, Ohio	9/57
Texaco-Cities Service Pipe Line Co. Tulsa, Oklahoma	5	12	Monee, Illinois, to Will County, Illinois	9/57
	4.36	18	Black Oak Junction to East Chicago, Indiana	9/57
Texas-New Mexico Pipe Line Co. Houston, Texas	512	16	Aneth, Utah, to Jal, New Mexico	UC

CRUDE LINES

Name of Company	Miles	Size	Location	Date Completed
Trans-Prairie Pipelines, Ltd.	18.17	6, 4, 3	Extensions to gathering system, Virden Roselea field	1957
Edmonton, Alberta, Canada	12.5	8	Weyburn field to Halbrite	1/57
	8.5	10	Halbrite to Midale	1/57
	28.5	8, 6, 4	Weyburn field gathering system	1/57
Union Oil Company of California	40	12	Junction to Oleum, California	5/57
Los Angeles, California	180	16	Lost Hills to Rodeo, California	5/57
Warren Petroleum Corp.	46	3½	Snyder to Big Spring, Texas	1956
Tulsa, Oklahoma				

PRODUCTS LINES

Name of Company	Miles	Size	Location	Date Completed
Buckeye Pipe Line Co.	116	8	Conversion, Huntington to Griffith, Ind.	8/57
New York, N.Y.	32	8	Conversion, Mantua to Youngstown, Ohio	9/57
Continental Pipe Line Co.	119	6-8	Conversion crude to products, Wichita Falls to Grapevine, Texas	8/57
Ponca City, Oklahoma				
Empresa Nacional del Petroleo	75	10	Concon to Santiago, Chili	UC
(Chilean Government) Santiago, Chile				
Great Lakes Pipe Line Co.	15	6	Lincoln, Nebraska to Lincoln AFB	4/57
Kansas City, Missouri	69	12	Middlebury Junction, to Chicago, Illinois	10/57
	34	12	Barnsdall to Tulsa, Oklahoma	10/57
	93	8	Newport, Minn. to Chippewa Falls, Wisconsin	1957
	165	8	Minneapolis, Minn. to Superior, Wisc., and Duluth, Minn.	1957
	11	8	Donahue to Bettendorf, Iowa	1957
	15.6	8	Replacement from Coffeyville to Independence, Kan.	1957
Gulf Refining Co.	113	10	Mont Belvieu to Lufkin, Texas	7/57
Houston, Texas	461	10	Conversion from crude to LPG, from Lufkin to Midland, Texas	7/57
	46	8–6	North Snyder to Coahoma, Texas	7/57
	89.5	8–6	Monument, New Mexico to Midland, Texas	7/57
	47	6–4	Waddell to Midland, Texas	7/57
	3.7	4	Phillips-Fullerton plant connection	UC
Interstate Oil Pipe Line Co.	152	4, 6, 8	Esso Baton Rouge refinery to Sorrento Salt Dome, Louisiana	9/57
Shreveport, Louisiana	9.12	4, 8	Esso Baton Rouge refinery to Grace Plant Terminal in Baton Rouge, Louisiana	7/57
Magnolia Pipe Line Co.	66	8⅝	Hull to Texas City, Texas	11/56
Dallas, Texas	35	4½	From Sweetwater gathering system to Sweetwater, Texas	10/56
	32	8⅝	Dollarhide to Andrews, Texas	11/56
	17	8⅝	Replacement from Mertens to Corsicana, Texas	10/56
	19	6⅝	Beaumont to Orange, Texas	1/57
	15	4½	Winkler County to Dollarhide, Texas	12/56
	22	4½	Jal, New Mexico, to Dollarhide, Texas	1/57
North Atlantic Treaty Organization	Approx. 2000	8, 10, 12	To various air fields in Europe	UC
Ohio Oil Co.	7	10	Clermont to Speedway, Indiana	9/57
Findlay, Ohio	85	12	Robinson to Champaign, Illinois	11/57
Oklahoma Mississippi River Products Line, Inc.	22.7	6⅝	Conway to Jacksonville, Arkansas	12/56
Tulsa, Oklahoma				
Petroleum Chemicals, Inc.	30	6	Lake Charles, Louisiana, to Orange, Texas	8/57
Lake Charles, Louisiana				
Phillips Chemical Company	93	4, 6	Sweeny to Pasadena, Texas	10/56
Bartlesville, Oklahoma	17	6	Sweeny, Texas, area	5/57
Phillips Petroleum Company	17	3	Oklahoma City, Oklahoma, area	10/56
Bartlesville, Oklahoma	216	2–12	West Texas area	4/57
	13	3, 6	Loops, West Texas area	7/57
Phillips Pipe Line Company	139	12	Loops from Borger, Texas, to St. Louis, Missouri	1/57
Bartlesville, Oklahoma				
Plantation Pipe Line Co.	327	18	Loop from Baton Rouge, La. to Helena, Ala.	12/56
Atlanta, Georgia				
Salt Lake Pipe Line Co.	8	8	Loop from Ontario to Adams, Ore.	UC
Salt Lake City, Utah				
Sohio Petroleum Co.	1	6	Relocation, Cincinnati, Ohio	3/57
Cleveland, Ohio				
Southern Pacific Pipe Lines, Inc.	21.9	8	Richmond to Concord, California	9/57
Los Angeles, California	106.4	10	Concord to Roseville, California	9/57
	33.4	6	Roseville to Colfax, California	9/57
	150	6, 8	Colfax, California to Fallon, Nevada	9/57
Standard Oil Co. (Ohio)	38.2	8	Mogadore to Niles, Ohio	12/56
Cleveland, Ohio	1.5	8	Lima, Ohio	10/57
Sun Pipe Line Co.	109.60	14	Replacement from Twin Oaks, Pa. to Newark, N. J.	11/56
Philadelphia, Pennsylvania				
Texaco-Cities Service Pipe Line Co.	168	6	East Chicago, Indiana to Lowell, Michigan	9/57
Tulsa, Oklahoma				
Texas Eastern Transmission Co.	230	14	Seymour, Indiana to Chicago, Illinois	UC
Shreveport, Louisiana				
Trust Pipe Line Company (Cosden subsidiary)	9	6	Hawley, Texas to Big Spring-Abilene line	10/56
	7.5	6	Colorado City, Texas to Big Spring-Abilene line	4/57
Big Spring, Texas	134	6	Hawley to Wichita Falls, Texas	UC
Union Oil Company of California	14	6	Rodeo to Richmond, California	7/57
Los Angeles, California				
Yellowstone Pipe Line Company	25	8	Spokane to Geiger and Fairchild Air Force Bases	6/57
Spokane, Washington				

GAS LINES

Name of Company	Miles	Size	Location	Date Completed
Alabama-Tennessee Natural Gas Co. Florence, Alabama	5.64	10	Loop, Limestone County, Alabama	7/57
Alberta Gas Trunkline Co., Ltd. Calgary, Alberta, Canada	17+	34	Cavendish to Saskatchewan Border	8/57
	97.3	18	Provost field to Cavendish	UC
	1050 ft	2	Suspension bridge across South Saskatchewan River	UC
American Louisiana Pipe Line Co. Detroit, Michigan	120.5	22	Defiance, Ohio to Bridgman, Michigan	11/56
	3.57	8	Lewisburg, Louisiana, lateral	10/56
	2.64	8	West Little Chenier, Louisiana, lateral	12/56
	139	12, 16	Cameron to Second Bayou and N. Holly Beach, Louisiana	UC
Arizona Public Service Co. Phoenix, Arizona	2	8	Phoenix to Scottsdale, Arizona	UC
	347	¾-6	Distribution lines throughout Arizona	12/57
Atlantic Seaboard Corp. Charleston, West Virginia	32.6	26	Loop from Gassaway, W. Va., to Seneca compressor station, Pendleton County	11/56
	5.7	26	Loop from Seneca station to Hardy County, West Virginia	11/57
Caroline Pipe Line Co. Greenville, South Carolina	177	2–10	Blacksburg to Camden, South Carolina	UC
Central Hudson Gas and Electric Corp. Poughkeepsie, New York	46	10	Albany to Kingston, New York	UC
Cities Service Gas Co. Oklahoma City, Oklahoma	28.30	16	Loop from Leavenworth, Kansas to St. Joseph, Missouri	10/56
	16.46	20	Loop from Edmond to Mulhall, Oklahoma	10/56
	3.55	12	Replacement, Concordia, Mo.	11/56
	9.15	16	Replacement, Springfield, Missouri	1/57
	3.80	8	Replacement, Springfield, Missouri	1/57
	3.53	16	Replacement, Pierce City, Missouri	2/57
	33.42	16	Replacement, Verden to Newcastle, Oklahoma	7/57
	6.20	8	Replacemnet, Pleasant Hill, Missouri	6/57
	2.62	4	Replacement, Pleasant Hill, Missouri	6/57
	15.57	26	Replacement, from Gardner to Glavin, Kansas	UC
Colorado Interstate Gas Co. Colorado Springs, Colorado	239.6	22	Denver, Colorado to Green River, Wyoming	1/57
	23.6	24	Loop from Morton Station, Kansas to Panhandle Main Line, Baca County, Colorado	1/57
	26.4	8	Loop from Pinion, to Portland, Colorado	1/57
	9.25	26	Loop, South Denver, Colorado	11/56
	2.6	20	Replacement, South Denver, Colorado	10/56
	49.4	22	Mocane to Hooker, Oklahoma	6/57
	31.3	4-22	Panhandle, Texas, field	7/57
	2.5	4-8	Keyes, Oklahoma, field	7/57
	8.4	4	Hugoton, Kansas, field	7/57
	17.0	4-8	Greenwood, Kansas, field	7/57
	140	4-24	Mocane, Oklahoma, field	UC
	53	4-18	Laverne, Oklahoma, field	UC
Colorado-Wyoming Gas Co. Denver, Colorado	2	8	Main line to No. Greeley, Colorado	7/57
Commonwealth Natural Gas Corp. Richmond, Virginia	40	18	Loop from Gum Springs to Chester, Virginia	3/57
	6	4–6	Lateral from Chester, Virginia, northeast	9/57
	13.25	12¾	From Petersburg, Virginia, southeast	UC
Consumers Power Co. Jackson, Michigan	31	16	South Lyons to Royal Oak, Michigan	12/56
East Ohio Gas Co. Cleveland, Ohio	112	24-30	Richfield Township, Summit County to Marion Township, Noble County, Ohio	1957
El Paso Natural Gas Co. El Paso, Texas	34.1	24	Ignacio plant to Blanco	Completed
	61.6	14	Jameson to Tex-Harvey plant	Completed
	34	20	Sweetie Peck to Goldsmith	Completed
	8.4	20	Loop, Jal No. 2, Jal No. 3, to Jal No. 1	Completed
	96	8⅝	Loop from Blanco to Wingate	Completed
	338.8	34	Loops from Blanco to Topock	Completed
	16.2	30	Loop, 2nd loop west of Gila	Completed
	149.3	20	New line from San Juan main line to Phoenix	Completed
	4.5	16	San Juan Maricopa line to Agua Fria power plant	Completed
	5.6	16	New line, Nevada Natural	Completed
	48.3	30	Lindrith to Chaco	UC
	0.6	24	Chaco to San Juan main line	UC
	6.8	20	Largo to Lindrith-Chaco line	UC
	22.5	20	South Andrews to TXL plant	Completed
	81	18	Panoma plant to Dumas plant	UC
	8.5	16	TXL plant to Goldsmith plant	Completed
	28.1	10¾	Westlake plant to Jameson	Completed
	78	34	Loops on San Juan main line	UC
Equitable Gas Co. Pittsburgh, Pennsylvania	6.1	6, 12, 16	Courthouse and Collins Settlement Dists., Lewis County, West Virginia	UC
	6.1	16	Jefferson Boro, Allegheny County, to Dravosburg Boro, Allegheny County Pennsylvania	1/57
	17.5	16	Penn Township, Allegheny County to Salem Township, Westmoreland County, Pennsylvania	3/57
	96	4, 5	Maytown, Kentucky to Institute, West Virginia	5/57
Gaz de France Paris, France	550	16–24	Lacq field to Paris	UC
	450	10–16	Laterals to Nantes and Lyons	UC
Government of Venezuela Caracas, Venezuela	207	26	Anaco to Caracas	UC
Gulf Interstate Gas Co. Houston, Texas	6.0	6	Southeast Houma, Louisiana	2/57
	0.5	4	Northeast Rayne, Louisiana	10/56
	4.8	4	North Maxie, Louisiana	11/56
	2.9	6	North Chalkley, Louisiana	11/56

GAS LINES

Name of Company	Miles	Size	Location	Date Completed
	0.7	4	North Erath, Louisiana	11/56
	5.1	6	Coles Gully, Louisiana	4/57
	1.3	6	Erath North-Tidewater, Louisiana	2/57
	0.9	8	Erath North Phillips, Louisiana	3/57
	0.7	4	Erath Tidewater, Louisiana	4/57
	1.5	4	Savoy Tidewater, Louisiana	6/57
Hope Natural Gas Company	3	18, 20	Replacement from Hastings station to Ohio River Clarington	8/57
Clarksburg, West Virginia	1	16	Replacement from Jones station to Stutler Junction	7/57
	1	20	Replacement from Jackson station to Fleming Junction	7/57
	1	18	Replacement from Hastings station to Round Bottom	8/57
	7.6	6, 8, 10	Gladys Wells to Seaboard	10/57
Inland Natural Gas Co.	304		Mainline Kamloops-Kelowna-Kootenay	UC
Vancouver, British Columbia, Canada	73		Lateral feeder lines	UC
Intermountain Gas Co.	16	6	Payette to Weiser, Idaho	9/57
Kansas-Nebraska Natural Gas Company	10.4	10	Replacement, Grand Island, Nebraska, north	6/57
Hastings, Nebraska	10.4	8	Loop, Grand Island, Neb., north	6/57
	11.5	12	Replacement from Scott City to Oakley, Kansas	5/57
	6.5	8-10	Baker station to Tyrone, Oklahoma	6/57
	9	8	Lexington to Canaday, Nebraska	9/57
	15.2	8	Replacement, Kimball, Nebraska, area	6/57
	13	6	Kimball, Nebraska area	6/57
	15	16, 12	Sterling, Colorado area	7/57
	450	1¼-6	New line, Nebraska and Kansas	8/57
Michigan Wisconsin Pipe Line Company	100.9	16, 20, 24	Loop line in Wisconsin	10/56
Detroit, Michigan	39.3	4, 6	Loop line in Wisconsin	12/56
	40.7	24	Loop line in Illinois	10/56
	15.7	4, 6	Lateral in Michigan	12/56
	39.6	6	Loop line in Iowa	11/56
	9.3	4	Lateral in Iowa	7/57
	1.0	4	Lateral in Illinois	8/57
	2.8	4	Lateral in Michigan	8/57
	24.5	24	Loop line in Wisconsin	UC
	2.7	6	Lateral in Wisconsin	UC
	21.5	24	Loop line in Illinois	UC
Mississippi River Fuel Corp.	54	26	Loop line from Perryville, La. to Columbia, Illinois	UC
St. Louis, Missouri				
Montana-Dakota Utilities Co.	28	12	Loop line from Glendive to Cabin Creek, Montana	10/56
Minneapolis, Minnesota	10	6	New line from Pine Unit to Cabin Creek, Montana	10/56
	34	10	Replacement from Whitewood to Rapid City, South Dakota	10/56
Mountain Fuel Supply Co.	38	20	Sweetwater County Wyoming, to southwestern Wyoming and Utah	9/57
Salt Lake City, Utah				
Natural Gas Pipeline Company of America	25	12	Quinduno field, Roberts County, Texas to Gray County, Texas	10/56
Chicago, Illinois	19	4-16	Quinduno field, Roberts County, Texas	10/56
	12	4-6	Twin field, Hansford County, Texas	5/57
	88	20	Wise County to Carter County, Texas	UC
	85	26	Carter County to Kiowa County, Oklahoma	UC
	174	26	Kiowa County, Oklahoma to Hutchinson County, Texas	UC
	135	4-20	Wise and Jack counties, Texas	UC
	1	20	Montague County, Texas to Love County, Oklahoma	UC
Natural Gas Storage Company of Illinois	15	20	Cooks Mills storage field, Douglas Co., to Moultrie County, Ill.	UC
Chicago, Illinois	4	8-16	Cooks Mills storage field, Douglas County, Illinois	UC
Nevada Natural Gas Pipe Line Co.	11.5	10, 12	Las Vegas to Apex, Nevada	UC
Las Vegas, Nevada				
New York State Natural Gas Corp.	15.3	30	Replacement from Horseheads to Newfield, N.Y.	7/57
Pittsburgh, Pennsylvania	31.1	20	17.9 mile replacement and 13.2 mile new line from Harrison, Pennsylvania to Woodhull, New York	UC
Niagara Mohawk Power Corp.	14	18	Loop from Phoenix to Palermo, N.Y.	UC
Syracuse, New York	225	2-16	New line throughout Niagara Mohawk system in N.Y. State	6/57
Ohio Fuel Gas Co.	7.9	8⅝	Loop, Champaign County	10/56
Columbus, Ohio	3.0	12¾	Replacement, Clark County	10/56
	7.0	18	Replacement, Clark County	10/56
	12.0	6⅝	New line, Morgan County	11/56
	6.0	16	Extension, Wood County	11/56
	6.0	12¾	New line, Hancock County	11/56
	5.1	16	Extension, Hardin County to Allen County	12/56
	2.6	20	Loop line, Lorain County	12/56
	36.7	24	Loop from Fairfield County to Licking County	7/57
	13.1	4-20	Storage lines, Vinton County	8/57
	16.3	3-6	Storage lines, Holmes County	UC
	4.1	20	Replacement, Madison County to Green County	UC
	2.5	18	Replacement, Clark County	UC
	6.3	12	New line, Sandusky County	8/57
	25.8	20	Extension from Lawrence County to Jackson County	UC
	24.3	18, 20	New line from Sandusky County to Lucas County	UC
	4.9	20	Extension, Lorain County	UC
	7.0	12	Extension, Madison County to Fayette County	UC
	7.3	16	Loop from Greene County to Clark County	UC
	4.3	20	Loop, Montgomery County	UC
	10.0	20	Loop, from Morrow County to Marion County	UC
	4.6	12	New line from Holmes County to Wayne County	UC
	35.8	24	Loop, from Sandusky County to Lucas County	UC
Oklahoma Natural Gas Co.	15.47	8	New line from Sec. 19-8N-18W to Sec. 6-17N-15W	11/56
Tulsa, Oklahoma	6.4	8	Replacement, vicinity Muskogee, Oklahoma	6/57

GAS LINES

Name of Company	Miles	Size	Location	Date Completed
Pacific Gas and Electric Co.	34	10, 8	From Daggett to Cushenberry Springs, California	3/57
San Francisco, California	78	20, 18, 12	From Beehive Bend Gas field to Sacramento, California	UC
	28.5	12, 10, 6	From San Ardo field to King City	11/56
	29.8	12, 10	From Las Vinas to Calaveras Cement Co.	UC
	29.1	12, 10	From Hinkley to Victorville	UC
	145	12	From Corning to Eureka	UC
	138.3	34	1957 looping of "Super Inch"	UC
	85.2	34	1956 looping of "Super Inch"	2/57
Pacific Northwest Pipeline Corp.	8.09	4	Sales lateral from Pullman to Moscow, Washington	7/57
Salt Lake City, Utah	28.3	6	Sales lateral from Spokane, Wash., to Coeur d'Alene, Idaho	8/57
	9.4	10, 6	Sales lateral from Rainier to Olympia, Washington	8/57
	35.3	6, 4	Sales lateral, from Monroe to Grotto, Washington	10/57
	35.9	6	Sales lateral from Coeur d'Alene to Kellogg, Idaho	10/57
	37.9	8	Sales lateral from Lind to Moses Lake, Washington	1/57
	3.84	3	Sales lateral from a point on Uruvan-Nucla Lateral to Union Carbide, Nuclear, Colorado	UC
Panhandle Eastern Pipe Line Co.	8.69	4, 6, 8	Gathering lines, Hugoton field of Texas, Kansas, Oklahoma	9/56
Kansas City, Missouri	.29	2, 4, 6, 8	Gathering lines, Hugoton field	10/56
	20.29	2, 4, 6, 8 10, 12	Gathering lines, Hugoton field	11/56
	6.944	6, 8, 10	Gathering lines, Hugoton field	12/56
	1.53	2, 4, 6	Gathering lines, Hugoton field	1/57
	6.40	4, 8, 10	Gathering lines, Hugoton field	2/57
	5.78	4, 6, 10	Gathering lines Hugoton field	3/57
	1.95	4	Gathering lines, Hugoton field	4/57
	2.40	4, 6	Gathering lines, Hugoton field	5/57
	13.81	4, 6	Gathering lines, Hugoton field	6/57
	.04	4	Gathering lines, Hugoton field	7/57
Peoples Natural Gas Co.	3.2	8	Butler County to Saxonburg, Pennsylvania	8/57
Pittsburgh, Pa.	3.2	20	Replacement, Cresson, Pennsylvania	9/57
	4	10	Replacement, Altoona to Tyrone, Pennsylvania	10/57
	1.7	8	Replacement, Kittanning, Pennsylvania	6/57
	2.5	12	Replacement, Valley station	7/57
	10	10	Gathering line for new wells, Johnstown	9/57
Permian Basin Pipeline Co.	83	16	From Eldorado station, Schleicher County, Texas, to Plymouth station	UC
Omaha, Nebraska				
Phillips Petroleum Co.	414	2-30	Andrews County, Texas, area	4/57
Bartlesville, Oklahoma	41	2-12	West Texas area	6/57
	276	4-20	Crane County, Texas area	6/57
	49	3-24	Loops, Odessa, Texas area	6/57
	96	2-20	Texas Panhandle area	4/57
	20	3-20	Hobbs, New Mexico area	4/57
	13	3–16	Eunice, New Mexico area	7/57
	28	2-8	Central Oklahoma area	10/56
Pioneer Gathering System, Inc.	18.18	8⅝	Schleicher County, Texas	9/57
Amarillo, Texas	22.92	16	Sutton and Schleicher Counties, Texas	9/57
	26.99	12¾	Val Verde and Sutton Counties, Texas	9 & 10/57
	24	Var.	Sutton, Schleicher and Val Verde Counties, Texas	9 & 10/57
Pioneer Natural Gas Co.	40.4	3½, 4½	Panhandle and South Plains of West Texas	1957
Amarillo, Texas	8.2	6⅝	Replacement, Lubbock and Crosby Counties, Texas	2/57
	12.8	6⅝	Replacement, Hale County, Texas	3/57
	9.6	6⅝	Replacement, Crosby County, Texas	2/57
	2.3	6⅝	Gaines County, Texas	12/56
	8.0	8⅝	Replacement, Lubbock County, Texas	2/57
	6.1	8⅝	Parmer County, Texas	5/57
	8.5	10¾	Replacement, Gaines County, Texas	1/57
	8.9	12¾	Loop, Lubbock County, Texas	6/57
	1.3	16	Replacement, Potter County, Texas	8/57
San Diego Gas and Electric Co.	2.4	10	El Cajon to Bostonia, California	6/57
San Diego, California	8.1	20	Mission Valley to National City	12/57
	6.2	20	Mission Valley to Morena	10/57
	5.1	4-16	Miscellaneous	1957
Saskatchewan Power Corp.	11.60	4	Millerdale to Kerrobert	7/57
Regina, Saskatchewan, Canada	4.12	2-4	In Kerrobert	7/57
	8.63	6	Kiyiu Lake to Kindersley	8/57
	15.26	8	Red Pheasant to Wilkie	9/57
	5.63	2-6	In Wilkie	9/57
	9.77	2-4	In Herbert, Morse, and St. Louis	8/57
	166.41	2-18	In Regina	9/57
Shamrock Pipe Line Corp.	29	4–12	Dallas and Sherman Counties, Texas	10/57
Amarillo, Texas				
Signal Oil and Gas Co.	80	Var.	Gathering lines in Tioga, North Dakota, area	10/57
Los Angeles, California				
Southern California Gas Co.	41	30	From Alhambra to Newhall, California	11/56
Southern Counties Gas Co.	241	30	From Newhall to Topock	8/57
Los Angeles, California	18	30	From Placentia to L. A. River	7/57
Southern Natural Gas Co.	26.76	12¾	Lake Enfermer field to Barataria line in Louisiana	1/57
Birmingham, Alabama	.65	8⅝	Kings Ridge field to Lake Enfermer line in Louisiana	12/56
	4.07	8⅝	Napoleonville field to west leg south Louisiana supply line	8/57
	7.2	8⅝	Manila Village field to Lake Enfermer line	UC
	.9	8⅝	Ft. Jackson field to Bastian Bay line in Louisiana	UC
	9.58	8⅝	Bastian Bay field to Fort Jackson Junction in Louisiana	UC
	3.95	12¾	Bastian Bay-Ft. Jackson Junction to Olga receiving station	UC

GAS LINES

Name of Company	Miles	Size	Location	Date Completed
Southern Union Gas Co.	8	8	Jicarillo field, New Mexico	11/56
Dallas, Texas	9.5	20	Loop, Sandoval County, New Mexico	10/56
	8	8	La Plata County, Colorado	10/56
	10	2	New distribution line, Humbolt and Mayer, Arizona	12/56
Spokane Natural Gas Co.	400	1–24	Spokane distribution lines	UC
Spokane, Washington				
Sui Gas Transmission Co.	217	16	Sui field, Pakistan, to Multan, Punjab	Fall 1957
Multan, Punjab, India				
Tennessee Gas Transmission Co.	34	30	Loop from Lancaster to Winchester, Kentucky	UC
Houston, Texas	24	30	Loop from Morehead to Greenup, Kentucky	8/57
	10	24	Loop near New Castle, Pennsylvania	8/57
		24	Triple underwater crossing of Mississippi River, near Greenville, Mississippi	UC
	107	26, 20, 16, 10	Kinder, Louisiana into Gulf of Mexico	UC
	20	30	Loop, southwest and northeast of Danville, Kentucky	10/56
	24	30	Loop east and west of Morehead, Kentucky	10/56
	241	26	Loop from Greenup, Kentucky to near Mercer, Pennsylvania	10/56
Texas Eastern Transmission Corp.	10	12	Loop, from Skippack to Broadaxe Junction, Pennsylvania	11/56
Shreveport, Louisiana	3	6	Aldine to Baytown, Texas	8/57
	152	3–12	New supply laterals	UC
	45	24	New line from Provident City to Blessing, Texas	UC
	626	30	Loops from Kosciusko, Mississippi to Uniontown, Pennsylvania	UC
	6	12¾	Loop from Broadaxe Junction to Conshohocken, Pennsylvania	UC
	10	12¾	Loop from Broadaxe Junction to Philadelphia, Pennsylvania	UC
	422	30	McAllen to Vidor, Texas	UC
Texas Gas Transmission Corp.	123	20	Eunice to Thibodaux, Louisiana	12/56
Owensboro, Kentucky				
Texas Illinois Natural Gas Pipeline Company	46	36	Loop, from Illinois River, Grundy County, Illinois to Cook Co., Ill.	UC
Chicago, Illinois	6	6	Bailey's Prairie oil field, Brazoria County, Texas	12/57
	3	4	Victoria County, Texas	2/57
Trans-Canada Pipe Lines, Ltd.	100.3	34	Alberta border to Leinan, Saskatchewan, Canada	11/56
Calgary, Alberta, Canada	110.2	34	Leinan to Belbeck, Sask., Canada	11/56
	90.2	34	Belbeck to Adair, Sask., Canada	8/57
	98.6	34	Adair, Sask. to Miniota, Man., Canada	8/57
	98.7	34	Miniota to Burnside, Man., Canada	8/57
	86.8	34	Burnside to St. Norbert, Man., Canada	8/57
	85.3	30	St. Norbert, Man. to Manitoba-Ontario border, Canada	9/57
	84.5	24–20	Sheridan to Newcastle, Ont., Canada	10/57
	116.0	20	Newcastle to Kingston, Ont., Canada	11/57
	139.6	20	Kingston, Ont. to Montreal, Quebec, Canada	11/57
	36	12¾	Morrisburg to Ottawa, Ontario, Canada	11/57
Transcontinental Gas Pipe Line Corp.	138	36, 30	Main line loops, various states	1956
Houston, Texas	11	24	Lateral line loop, Louisiana	1956
	311	36, 30	Main line loops, various states	12/57
	41	24, 16	Lateral line, Louisiana	12/57
	243	24 and smaller	Lateral line, Texas	12/57
Union Gas Company of Canada, Ltd.	12	20	Payne pool to Dawn Compressor station	8/57
Chatham, Ontario, Canada	142	26	Dawn Compressor station to Trafalgar Township	11/57
	12	12	From 26-in. line to Kitchener	10/57
	3	10	From 26-in. line to London	10/57
	12	10	From 26-in. line to Guelph	10/57
	12	8	From 26-in. line to Stratford	10/57
	7	6	From 26-in. line to St. Marys	10/57
	7	20	From 26-in. line to Hamilton	10/57
United Fuel Gas Co.	15.7	12	Coco to Belle, West Virginia	12/56
Charleston, W. Virginia	1.3	10	Frame, West Virginia to Line SM-80	1/57
	11.1	12	Maytown to Boldman, Kentucky	7/57
	7.7	12	Replacement between Spencer compressor station, Roane County, West Virginia and Ravenswood, West Virginia	10/57
United Gas Pipe Line Co.	48.5	20	Deep Lake field to Lake Charles	8/57
Shreveport, Louisiana	39.5	8	From existing facilities serving Pensacola, Fla. to Brewton, Ala.	9/57
	9.3	4	From existing facilities near Jasper, Texas to Newton, Texas	9/57
	9.1	8, 10, 12	Grand Chenier, Louisiana to Crab Lake field and Forrest Oil Company's Block 4 in Gulf of Mexico	9/57
	6.8	6	From Deep Lake field line to West Chenier Perdue field near Creole, Louisiana	8/57
	6.4	8	From existing facilities southeast of Liberty, Texas to Trinity River Delta field near Anahuac, Texas	Completed
Washington Natural Gas Co.	13.9	16, 12, 4	Supply main from Seattle to north Seattle gate station	11/56
Seattle, Washington	12.4	12	Supply main from No. Seattle gate to Everett, Washington	11/56
	2.9	6	Supply main from Everett to Marysville, Washington	UC
	11.6	8–6	Supply main from Renton to Puyallup, Washington	UC
	8.3	8, 6, 4	Supply main from Olympia to Olympia Border Station	UC
	4.5	12–6	Industrial lateral from Tacoma supply to American Smelter	UC
	1.2	4	Supply main from Issaquah gate station to Issaquah	8/57
	2.9	6, 4, 2	Distribution main from housing development to Kirkland-Bellevue	10/56
Westcoast Transmission Co.	650	30	Taylor, B. C., to Sumas, Washington	10/57
Calgary, Alberta, Canada				
Western Slope Gas Co.	36	4	Piceance Creek field to Rifle, Colorado	10/57
Grand Junction, Colorado				

Tecumseh Fills Need for more Crude into Ohio

With one station, 100,000 bbl per day will be delivered through this new 20-in. carrier

Walter M. Bellairs
Assistant Chief General Engineer
Sinclair Pipe Line Company

THE TECUMSEH Pipe Line Company system was placed in operation the latter part of September. This new 20-in. crude oil line from Schererville, Indiana, to Cygnet, Ohio, approximately 201 miles in length, provides needed additional capacity from the Chicago area to Ohio (see Fig. 1). At Cygnet, a connection has been made with Buckeye Pipe Line Company for delivery to points north, south, and east.

Tecumseh Pipe Line Company, an Ohio corporation, is owned by Sinclair Pipe Line Company, The Pure Oil Company, and Ashland Oil and Refining Company. Sinclair was selected to be the agent for construction and operation. The construction office was located at Elkhart, Indiana; the main office is at Independence, Kansas.

Initially, only one pump station was installed. This station, called Hartsdale station and located in Schererville, can pump approximately 100,000 bbl per day. The line has been designed to operate at a maximum pressure of 1000 psi.

Line pipe used was API 5LX-52 and was telescoped using three wall thicknesses, except that API 5LX-42 with 0.500-in. wall thickness was used for river crossings.

Line pipe at the discharge side of the Hartsdale station is 0.344-in. wall, followed by 0.312-in. wall, and finally 0.281-in. wall. Provisions have been made for a future intermediate station, near Ligonier, Indiana, with the three different wall thicknesses used again eastward from this point.

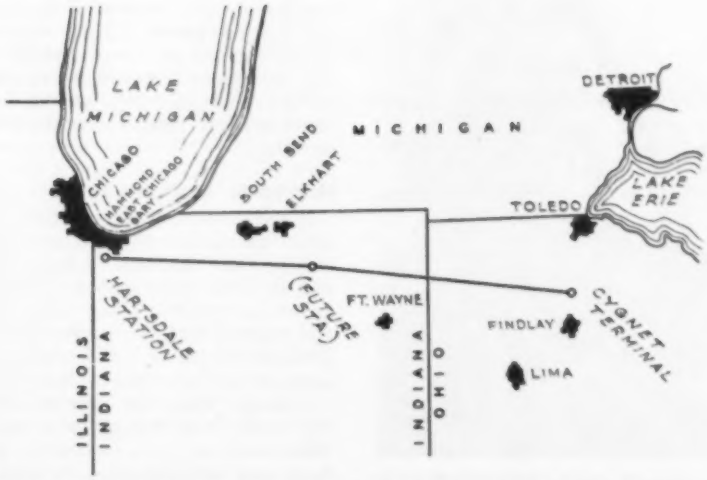


FIG. 1. Route of Tecumseh line from Schererville, Indiana, and Cygnet, Ohio.

Line pipe is both seamless and electric weld.

Line location is mainly through farming areas where the terrain is relatively flat; however, the first few miles are in towns and suburban areas that are rapidly being developed. Actual elevations vary from 630 ft at Hartsdale station to 950 ft near Ligonier and down to 710 ft at Cygnet, all elevations being feet above mean sea level.

While preparing the specifications for bids, it was decided to divide the line into three sections:

Section 1 consists of the first 16 miles east from Hartsdale station. This section is through the heavily populated area, and the line not only crosses many pipelines, water lines, sewer lines, etc., but in some cases is alongside such lines.

Section 2 is approximately 93 miles in length and extends from near Wheeler, Indiana, to a point south of Brimfield, Indiana. Parts of this section were swamps years ago and have been reclaimed for cultivation by digging drainage ditches and laying drain tile. Fig. 2 shows an occurrence that happened many times in Indiana.

Section 3 is approximately 92 miles in length and extends from near Brimfield, Indiana, to Cygnet, Ohio. The part in Indiana is similar to that in Section 2, whereas the remainder in Ohio is clay and a heavy loam. Drain tile encountered in this section was quite a problem, especially in respect to backfilling and clean up.

Section 1

The contract for Section 1 was awarded to Morrison Construction Company of Hammond, Indiana. Due to restricted working space in many places, it was decide to use mill coated and wrapped pipe. A semi-plasticized coal-tar enamel was used together with glass fiber wrap followed by a final wrap of kraft paper. Minimum thickness of this coating was ⅛

in. Field joints, or welds, were coated by flood coating and wrapping with pipeline felt.

It has been necessary to use well points and dewater in many places. One stretch dewatered was 2 miles in length. Recent record-breaking rain in the Chicago area further complicated matters and it was necessary to wait for the water to run off in order to find some of the well points.

Cathodic protection is also quite a problem on this section and it was necessary to install two insulating flanges in order to isolate one critical area from the rest of the line. These flanges are in addition to the insulation provided on one side of each of two block valves in the line.

Sections 2 and 3

The O. R. Burden Construction Corporation, of Tulsa, Oklahoma, was awarded the contract for construction of the remainder of the line, approximately 185 miles.

Two spreads were started by this contractor with the spread for Section 2 headquartering first in Valparaiso, Indiana, later moving to Nappanee, Indiana. Section 3 spread first located in Kendallville, Indiana, then moved to Defiance, Ohio.

Line pipe and coating material deliveries were scheduled to begin shortly before actual construction began. Pipe deliveries began the latter part of April and were completed early in June.

The coating for these two sections was applied over the ditch. Procedure involved the usual traveling cleaning machine, which applies the primer immediately behind the cleaning. This was followed by a minimum coating of 3/32 in. of asphalt enamel into which a wrap of glass fiber was pulled, followed by a wrap of 50-lb kraft paper. On all road and railroad crossings, river crossings, and sections that were dragged into place, the standard coating (less kraft paper) was followed by a flood coat of enamel.

River Crossing

The only river crossing of any consequence was the Maumee River near Defiance, Ohio. This river, although normally only about 2½ ft deep, is about 700 ft wide. The bottom is solid rock and Fig. 3 shows the result after shooting a short stretch of the ditch. The river is also under the jurisdiction of the U. S. Army Corps of Engineers and they required that the line have 3 ft of cover, measured from the top of the river weights rather than top of the pipe.

Another obstacle was the old Miami-Erie canal on the west bank of the river. This canal, started in 1825 and completed in 1845, is maintained by the state park system. The canal crossing was made by boring underneath it, in the same manner as a highway crossing.

River weights used on the line are conventional bolted concrete weights weighing 4400 lb. On Section 1, a few "set on" weights were used in the areas that were dewatered. To give an idea of the extent of the high water table level 1600 weights were ordered for installation on the line.

FIG. 2. TD 24 sideboom tractor carrying cleaning machine is stuck in peat bog. This was not an unusual occurrence.

The Author

Walter M. Bellairs is assistant chief general engineer for Sinclair Pipe Line Company. He was graduated from Kansas State College in 1936 with a bachelor of science degree in civil engineering. Worked in the design department of the Kansas State Highway Commission for one year after completion of his schooling.

In June 1937, Bellairs joined the engineering department of Sinclair and in 1941 was assigned to pipeline construction in Venezuela. In 1943 he entered the services of the U. S. Navy and was named a Lieutenant Junior Grade. He returned to his duties in the engineering department in 1946 and was made assistant chief engineer in 1953.

In recent years he has been engaged in the supervision of crude pipeline construction and in September 1956 was named project manager of the Tecumseh Pipe Line project in charge of construction.

Many Drain Tile

The number of drain tile in these sections, and particularly in Section 3, delayed progress considerably. In some fields drain tile was intercepted every 33 ft. Each tile was carefully marked by stakes when they were cut by the ditching machines. After the pipeline was in the ditch tile repairs were made. To repair, the tile was uncovered 2 or 3 ft on both sides of the ditch and a rod run through the tile to the limits of the right-of-way. This located any tile that may have been crushed by the construction equipment. Then a support was laid across the ditch to hold the tile. The support consisted of 8-in. pipe cut in half longitudinally. New tile was then laid in this pipe slab and the ditch backfilled.

Hartsdale Station

A site containing approximately 79 acres was obtained in Schererville, Indiana, for Hartsdale station. This site, like most of the land in that area, is low and required filling before station building could be erected. In addition, it was thickly wooded and considerable time was spent in clearing.

Tankage consists of nine 100,000-bbl tanks with double deck roofs. These tanks are 134 ft in diameter and 43 ft high with maximum oil level at 40 ft. The extra 3 ft is considered a

FIG. 3. A view of Maumee River crossing after a portion of the ditch was blasted.

wind skirt to protect the roof shoe and keep the roof from projecting above the shell when the tank is full. Each tank has one 24-in. line connecting it with the manifold, acting as a combination filling and suction line. Appurtenances include two 25-hp mixers, automatic tank gage, spiral stairway, rolling ladder with self leveling treads, two extra nozzles, an extra shell manway, and a cleanout door.

Core samples showed that the soil had a relatively low bearing capacity and for that reason it was decided to use 40-ft high tanks rather than 48-ft tanks with smaller diameters. Tests also indicated that the tanks would settle approximately 2 in. when they were filled. Building footers were designed so that no more than ¼ in. of settling should occur. Before building each tank grade it was necessary to remove the topsoil and replace it with sand; the amount of topsoil varied from 6 to 24 in. This sand fill was very carefully compacted by rolling as it was put in place. After completing this subgrade a trench was excavated at the shell location for a compacted crushed rock foundation. The remainder of the tank grade had 3 in. of crushed rock spread on it.

The pump station building is "L" shaped with the control or office part made of concrete blocks with brick exterior. The pump room is a steel building with galbestos siding.

The control room contains not only the control console desk but also the switchgear and loadcenter. A separate room serves as a shop and garage.

Main line pumping units consist of one 10-in. single-stage centrifugal pump powered by a 500-hp motor and three 8-in. 3-stage pumps with 1000-hp motors. These units are 1800 rpm and the motors are rated 2300 v, 3 phase, 60 cycle, and are the self-ventilated type. Motors are set close to one wall of the pump building and suction and discharge air ducts come through the wall.

Three booster pumps are set at the manifold to take the oil from the tanks and deliver it to the main line pumps. These pumps are "in line" centrifugals consisting of two 12 in. and one 8 in. They are manifolded to provide for blending of two different grades of crude oil. This is controlled by ratio controllers, mounted in the console, which get their information from orifice flanges in the two discharge lines from the booster pumps. The ratio is controlled by operating a control valve on one of these discharge lines.

The main line pumping units are operated by pushbuttons on the console. Operation of these buttons will initiate the sequence operation of the pump valves and main line motor provided the "Hand-Auto" selector in the switchgear cubicle is in the "Auto" position. A pushbutton is also situated on each motor to start the motor when the selector switch is in the "Hand" position. The stop button on each motor will stop the motor regardless of the position of the "Hand-Auto" selector. Each motor has bearing and stator over-temperature protection, and the pumps have bearing and case over-temperature protection. Each pump also has hydraulic pressure switches to protect against low suction.

Valves on the suction and discharge lines to these main line pumping units can be operated by pushbuttons at each valve. The sequence circuit provides interlocks so that the closing of either the suction or discharge valves will shut down the motor on the pump involved.

Each motor-operated valve in the manifold can be operated from the console by dialing the proper selection code. When this is done a light blinks to indicate the valve selected and then the operator pushes the appropriate button marked open-stop-close.

Tank mixers are operated similarly in that dialing the selection code makes a light blink to show the tank selected and when the start or stop button is pushed both mixers on the tank will start or stop together.

Cygnet Terminal

The terminus of this new line is adjacent to Buckeye Pipe Line Company's tank farm at Cygnet, Ohio. At this point, in addition to the usual scraper trap, Tecumseh has installed three meters for measuring the crude oil. These are 8-in. meters and a 2500-gal prover tank was provided for proving the meters. An automatic sampler was also installed. Meter readings are accumulated for transmittal to Hartsdale station. The operator at Hartsdale station receives this accumulated meter reading anytime he desires by merely pressing a button.

After passing through the meters the oil goes to a manifold for delivery to any of five tanks. To protect the Series 15 valves from damage due to accidental closing off against the line pressure a bursting head has been installed in a by-pass line. This bursting head will rupture at 200 psi and allow the oil to go to a tank. If this happens an alarm is sounded at Cygnet and a signal transmitted back to Hartsdale station and the pumping units are shut down. To protect the main line from damage due to the valves being closed at the scraper trap a pressure switch is connected to the line and at a preset pressure will transmit a signal back to Hartsdale station and shut down the pumping units.

A small building is provided to house personnel and to provide a laboratory for testing the oil delivered. ★

'LITTLE BIG INCH'

Reconverted In Record Time

Work began the day after FPC gave approval, and the wartime pipeline that was converted to gas transportation following World War II is now back to its original service

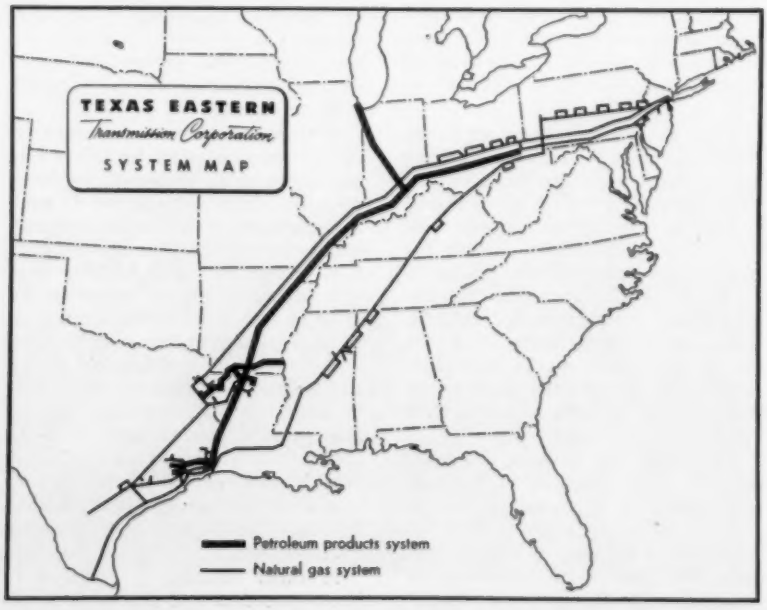
TEXAS EASTERN Transmission Corporation has put final touches to reconversion of its Little Big Inch pipeline from a natural gas carrier to one of the nation's largest common carriers of petroleum products, and the 1700-mile system is now ready for operation.

Construction of a 14-in. diameter lateral from a point on the Little Big Inch mainline at Seymour, Indiana, to Chicago, Illinois, began on August 1, was completed by the end of September, and is the newest part of the system.

Pump stations to move the products were completed, tested, and pronounced ready for operation early in September. They consist, at present, of five main control stations and six remotely-operated or satellite stations.

The control stations are at Baytown and Beaumont, Texas; El Dorado, Arkansas; Buncombe, Illinois, and Seymour, Indiana. The satellite stations are at Many, Louisiana; Emmett, Arkansas; North Little Rock, Arkansas; Walnut Ridge, Arkansas; Oran, Missouri, and Norris City, Illinois. Each control station will operate its own facilities as well as those of the satellite pumping stations on its downstream side. Control will be accomplished by means of leased telephone lines and microwave relay equipment.

Up until last June 21, Texas Eastern was pumping a full load of natural gas through the Little Big Inch. On that date, the Federal Power Commission once again authorized the company to remove the line from natural gas service thus opening the way for the reconversion program to begin. Texas Eastern has previously received authority from the FPC to remove the line from gas service back in 1955 but had to call off the project when opposing forces managed to have the entire issue remanded to the commission for further hearings.



Map shows the "Little Big Inch" products system in relation to Texas Eastern's natural gas lines.

Crews Were Poised and Ready

When the final FPC approval was given, Texas Eastern had crews poised and ready. The next day they were at work, and in less than three months the line was ready to begin carrying products.

The first problem was to remove the line from gas service and clean out the gas. Reconditioning the line was another major undertaking, which included pressure testing to assure continued safe operation of the line when it was placed back in service. The work was accomplished in stages, the first begun in June and the last completed in late August.

The first segment of the line to go out of gas service was a 16-in. section between Baytown and Beaumont, Texas. Next, sections from Beaumont up to Seymour, Indiana, were removed and tested. Compressors were used to pump most of the gas out of the line. The small amount of gas remaining in the pipe was then vented to atmosphere. The line was hydrostatically tested in short sections.

Reconditioning consisted of removing all cross connections that linked the line with the Big Inch pipeline and

Some states not traversed by the line nevertheless will be served indirectly by river barge, tank car, and tank truck. Here a barge is receiving a cargo of products at Texas Eastern's Arkansas City terminal on the Mississippi River.

other natural gas facilities along the route of the Little Big Inch right-of-way, removing and replacing all weak sections of pipe, and tying in with pumping facilities.

Construction of new storage tanks and reconditioning of old ones, plus construction of new pumping and switching facilities at Beaumont, progressed rapidly with final completion late in August. All facilities at Baytown, El Dorado, and Seymour, also were completed and final clean-up made in August.

Texas Eastern's expanding products system will serve a 13-state market area, comprised of Minnesota, Wisconsin, Michigan, Iowa, Arkansas, Missouri, Illinois, Indiana, Ohio, Kentucky, Tennessee, West Virginia, and western Pennsylvania. Some of these states that are not traversed by the Little Big Inch or the new Chicago lateral line will be served by a combination of the Little Big Inch and other facilities such as river barges, tank cars, tank trucks, and other common carrier pipelines.

A complete range of petroleum products, including liquefied petroleum gases, will be shipped through the reconverted line. Initial maximum capacity is 185,000 bbl a day.

A Wartime Beginning

The story has a wartime beginning. German submarines threatend to choke off oil supplies for East Coast refineries in the early days of America's World War II effort. Scores of tankers were sunk, many in view of civilians along the Atlantic shoreline. The transportation of petroleum — vitally needed to lubricate and power the country's industrial army —became one of the most urgent problems of the domestic war effort.

If it could not be carried from the oil-rich Southwest by tankers, then it would have to travel by land. The answer was a pipeline. Two, in fact. The first was a 24-in. crude oil carrier, which was promptly nicknamed the "Big Inch." It was shortly followed by a 20-in. refined oil products line that quite logically became the "Little Big Inch."

Even to a country accustomed to its own industrial ingenuity, the short time needed to meet the emergency was almost unbelievable. The Big Inch was only a year in building. The Little Big Inch pumped vital petroleum products to Eastern points less than a year after the first lengths of pipe had been laid.

Wartime wards of the government, the 20 and 24-in. carriers were offered for public sale in 1946, and in the following year were bought by Texas Eastern Transmission Corporation, an organization formed to bid on the lines.

The "Inch" lines, which had begun by serving our war machine, were shifted to the transportation of natural gas and rendered equally important service to the post-war economy. The lines moved natural gas into the Appalachian regions of the East where expanding industry and extensive home building provided a growing demand for the pipelines' products. When Texas Eastern removed the Little Big Inch from gas service, it returned the line to the service for which it was originally designed and built.

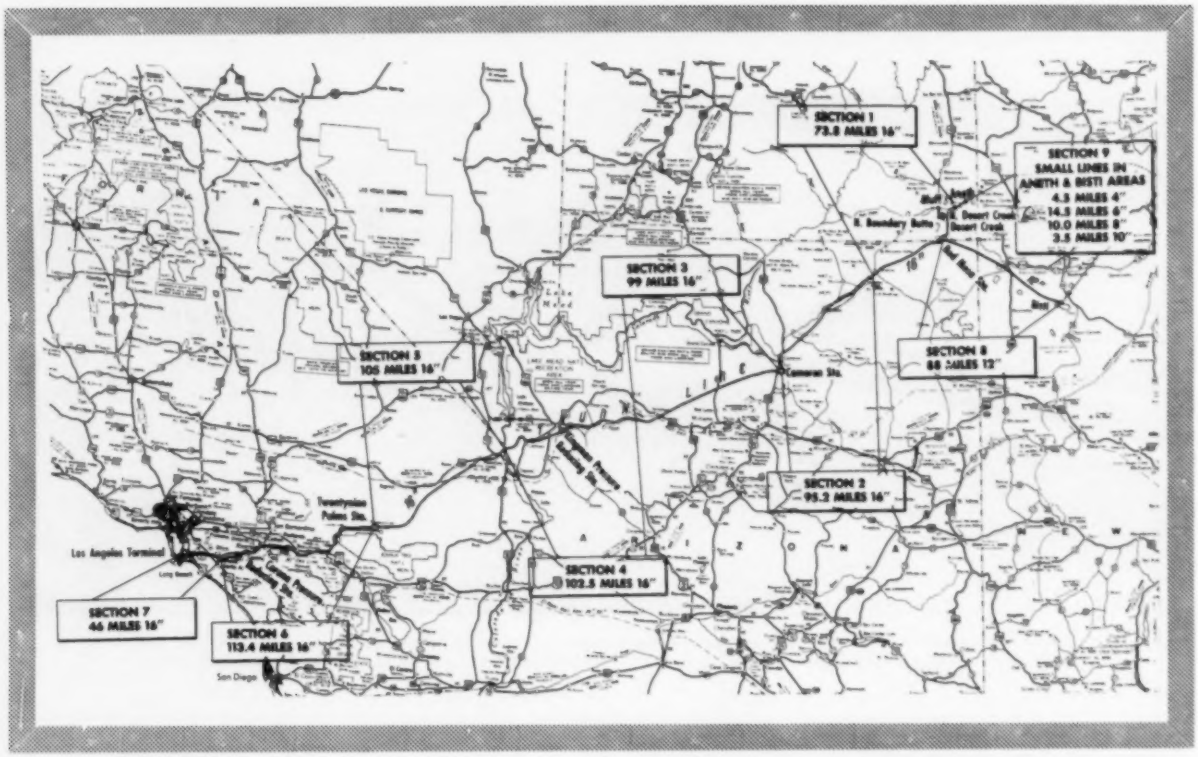
In 1954 Texas Eastern sought Federal Power Commission permission to remove the Little Big Inch from natural gas service so that it could then be reconverted to a common carrier of petroleum products. Lengthy and regulatory proceedings delayed the start of reconversion until June, 1957.

Triangle System

In 1955 the company acquired Triangle Pipeline Company, a petroleum products transportation company operating in East Texas, Northwest Louisiana, and southern Arkansas. These facilities, which include a major water terminal on the Mississippi River at Arkansas City, Arkansas, have been connected to the reconverted portion of the Little Big Inch at El Dorado, Arkansas, to become an integrated part of Texas Eastern's petroleum products system.

The Operations Team

Directing operations of the company's new products system is Millard K. Neptune, executive vice president, petroleum products division. Assisting Neptune are vice presidents J. B. Saunders and C. L. Brockschmidt; H. M. McDonald, general manager of the petroleum products division, J. D. Bland, general superintendent, as well as many others. ★ ★ ★



Route of the Four Corners Pipe Line system. The line was divided into sections for purposes of contract letting, as shown here.

First Pipeline from FOUR CORNERS Area

750-mile system to Los Angeles will go into operation about February 1

Frank H. Love
Editor

FOUR CORNERS, "hottest" onshore area at the moment and one that promises the greatest play in many years, is on its way to having a pipeline outlet at long last. Four Corners, so called because it embraces the territory where the states of Utah, Colorado, New Mexico, and Arizona touch, has reserves estimated as high as 400,000,000 bbl, but as yet no oil pipelines to move its production to market.

Four Corners Pipe Line Company now has well underway its 750-mile system, which will take oil to the Los Angeles, California, area. It will be in operation by February 1, according to present plans.

One other pipeline for certain will be completed to serve the area within the next 12-month period; there may possibly be two. Texas-New Mexico began construction the latter part of September on a 515-mile system from Aneth field, Utah, to Jal, New Mexico, where it will connect with an existing line to the Gulf Coast. Northwest Pipe Line Company, subsidiary of Pacific Northwest Pipe Line Company, which is taking gas from the area, has announced plans for a 500-mile crude oil and products line to Salt Lake City, Utah, but no contracts have been let.

These could be the forerunners of other pipelines from the prolific San Juan and Paradox basins.

At present crude is being shipped by truck and rail with some going to nearby refineries in New Mexico. Lack of pipeline facilities has been a deterring factor in development work. Start of construction on the Four Corners Pipe Line has given a decided boost to exploration and drilling activities. By recent count there were approximately

On grades as steep as this one sag bends are set down tight and the overbend carried high, eliminating the need for riprapping.

Firing line welders on eastern end of line near Marsh Pass, Arizona.

150 rotary rigs in operation and some half a hundred exploratory crews.

Although activity is intense and estimated reserves have been placed in the hundreds of millions of barrels category, actually no one knows with exactness the potential. Development, in the modern sense, dates back not more than two and a half years, although some oil was found in the Paradox Basin as early as 1907 and in the San Juan Basin in 1911. It was not, however, until Shell's Desert Creek No. 2 discovery in 1954, El Paso Natural's Bisti field discovery in 1955, and Texas Company's "big" production discovery at Aneth in 1956, that the new oil play began. The Four Corners area now includes 15,000 to 20,000 sq miles.

Who Owns the Pipeline?

Four Corners Pipe Line, which will cost $50,000,000, is being built by a group of six major oil companies. Owners are Shell Oil Company, 25 percent; Standard Oil Company of California, 25 percent; Gulf Oil Corporation, 20 percent; Continental Pipe Line Company, 10 percent; Richfield Oil Corporation, 10 percent, and Superior Oil Company, 10 percent. Shell Pipe Line Corporation designed the system, is doing the construction, and will operate it.

Who Are the Contractors?

For purposes of awarding construction contracts the line was divided into nine sections. Location of sections, size of pipe, and mileages are as follows:

Section 1—74 miles of 16-in. from Aneth field, southern Utah, to Kayenta, Arizona.

Section 2—95 miles of 16-in. from Kayenta to Cameron, Arizona.

Section 3—99 miles of 16-in. from Cameron to Seligman, Arizona.

Section 4—103 miles of 16-in. from Seligman west to the Colorado River.

Section 5—105 miles of 16-in. from the Colorado River to Twentynine Palms, California.

Section 6—113 miles of 16-in. from Twentynine Palms to Olive, California.

Section 7—46 miles of 16-in. from Olive to Los Angeles.

Section 8—88 miles of 12-in. from Bisti field, New Mexico, to Red Mesa station in Utah, about 20 miles southeast of Bluff, Utah.

Section 9—33 miles, 4, 6, 8, and 10-in. feeder lines connecting various fields in Utah and New Mexico. The fields from which crude will be taken include Bisti and Carson in New Mexico; Aneth, Recapture Creek, Bluff, North Desert Creek, West Desert Creek, Mole Hill, Desert Creek, North Boundary Butte, Boundary Butte, in Utah.

Contracts for all of the 750 miles have been awarded. These went to A. P. Vaughn Construction Company, Fort Worth, Texas; R. H. Fulton Construction Company, Lubbock, Texas; Potashnick Construction Company, Cape Girardeau, Missouri; Pacific Pipeline Construction Company of Montebello, California, and Standard Pipe Line Construction Company of Farmington, New Mexico.

The Vaughn and Potashnick firms jointly are constructing sections 1, 2, 4, and 8. Pacific has section 7, Standard section 9, and Fulton sections 3, 5, and 6. The latter is now working on section 3 and will not start on sections 5 and 6 until the middle of October, avoiding desert work during the hot summer months.

Route of Line

The right-of-way varies from a high elevation of 6700 ft to sea level at the Los Angeles terminus. At its originating point the elevation is 4500 ft, but rises to 6700 ft near Kayenta, Arizona, then drops down to 4500 ft at Cameron, Arizona, but immediately rises again to 6500 ft just west of Cameron. From that point the drop is steady and at the end of Section 4, on the Colorado River, is only 450 ft. It climbs

Multiple pneumatic drills borne by sideboom tractors are used to punch holes for explosive charges where rocky areas require shooting.

again, however, to an altitude of 3500 ft at Twentynine Palms, then steadily declines to sea level at the terminus in Los Angeles, which will be in the vicinity of Wilmington.

The eastern portion of the line is a land of sand and rock, barren wasteland for the most part, albeit picturesque. It passes largely through the Navajo Indian Reservation. In a land so unproductive the Navajos have depended for livelihood on herds of sheep and goats, small patches of corn where water is available for irrigation, and the like. Although many of the 88,000 members of the tribe still live in hogans, oil has poured more than $50,000,000 into the tribal coffers from bonus payments for oil leases. Payments for pipeline right-of-way has added to this amount. These monies are being used for schools, hospitals, roads, and establishment of light industries. Such long-range plans cannot help but make a great change in the Navajo's way of life. Immediately he is being helped economically with work in the oil fields and on Four Corners Pipe Line construction.

On the extreme west end of the line, some 45 miles will be in Metropolitan Los Angeles, starting at Olive, a suburb. Such congested conditions always present construction problems, and in this instance railroad and power line rights-of-way will be used as much as possible.

Whenever possible the right-of-way has been made to skirt the rocky and hilly areas. This has not always been feasible, however, and considerable blasting has been necessary. In sections 1 and 2 there has been an intermixture of sandstone that could be cut with ditchers, and rock that has to be shot and removed with clamshells and backhoes, then padded with dirt before pipe can be laid.

Immediately out of Cameron west, where Section 3 begins, rock starts and continues for about 20 miles, virtually all of which had to be shot. From that point on into Seligman, about 15 miles, the terrain is hilly with brush and some timber. Then rock begins again and exists generally through Section 4, or to the Colorado River about five miles north of Needles, California, when it climbs back up into the hill country for a short stretch, then drops off into the desert. The desert lasts into Edgemont and from there to Olive are California fruit groves.

Backhoes and clamshells are used to clear the ditch of rock after blasting. Depth of rock ditch is about 5 ft.

Pipe will be carried across the Little Colorado River on this suspension bridge, constructed in 1912 under the auspices of the Navajo Indian tribe.

Construction Methods

A tricky problem in laying pipeline through desert country is the dry washes. In dry weather these washes are harmless enough looking, but as anyone knows who has laid a pipeline or lived in this section of the country, they became raging torrents in a matter of minutes when sudden rain occurs. They can cause havoc to a pipeline unless it is buried deep enough. Four Corners is covering the pipe to a depth of 7 ft when laid in sandstone or loose rock. If in solid rock it is laid to a depth of 1 ft. The main line otherwise is being given a 3-ft cover.

When in solid rock the ditch is padded with dirt. Sometimes sand is close at hand that can be used for this purpose; sometimes the dirt has to be hauled from a considerable distance.

Lineup and welding is following customary methods. Welding practice is in conformity with API Standard 1104. Because of deep sand in some place, welding machines must be mounted on four-wheel trucks or the regular equipment pulled along the right-of-way by tractors.

Coating is approximately 60 percent asphalt and 40 percent coal-tar enamel. Glass fiber and asbestos felt wraps are used. In the Los Angeles Metropolitan area the pipe will be yard-coated with Somastic.

A standard program of casing and venting highway and railroad crossings is followed.

Three Major River Crossings

Three major river crossings will be made. Two will be buried and one carried on a highway bridge.

The San Juan River crossing is on one of the 16-in. feeder lines, where the water span is approximately 1300 ft. This is a buried crossing as the river has a sand and gravel bottom. Working from the north bank the line was pulled into position. Air and hydrostatic tests were given each section of pipe, and before the completed crossing was tied into the main line a scraper was run and an additional hydrostatic test made. Pipe having a wall thickness of ½ in. was used and this gave the negative buoyancy required.

For protection three coatings and wraps were applied. Each coating consisted of 2/32-in. coal-tar enamel. The first and second wraps were of glass fiber only, the third of glass and asbestos felt. Depth of burial was 7 ft.

The Little Colorado River will be

Pipe is being coated with asphalt and coal-tar, wrapped with glass fiber and asbestos felt.

The eastern portion of the line is almost entirely on the Navajo Indian reservation. This Navajo family is shown before a drilling well in the Aneth field.

crossed at Cameron, Arizona, on a highway bridge. The latter is no ordinary bridge but is of unusual construction and has an interesting history. It is a suspension bridge with box trusses suspended on cables, and was constructed in 1912 under the auspices of the Navajo Indian tribe, one of the first two so designed. The pipeline will be suspended from the top members of the box trusses. Protection will consist of a prime paint only, as the pipe will not be subject to all the corrosive conditions of a buried line and can be easily inspected. The span will be 850 ft in length.

The Colorado River will be crossed with a buried line five miles north of Needles, California. Total length is 900 ft, with a 500-ft water span. Because of potential scouring, the pipe will be triple-coated with enamel and glass fiber wrap then concrete-coated. The trench will be dredged and backfilled with the pipe buried from 10 to 20 ft.

Line Pipe

Line pipe is API 5LX52 and comes in 40-ft random lengths. In the main, wall thickness is ¼ in. The line is telescoped, however, wherever the hydraulic gradient and surface elevation necessitate extra weight for protection against excessive pressures. In such instances the wall thickness ranges from ¼ in. to ⅜ in., graduating in 1/32-in. increments. River pipe is ½-in. wall API 5LX42.

Archeological Studies

As other pipeline companies have done whose systems pass through territory where archeological treasures lie hidden, Shell has worked closely with the U. S. Department of Interior at Santa Fe, New Mexico. Under the supervision of Dr. Jesse L. Nusbaum, senior archeologist for the National Park Service, and since 1927 consulting archeologist for the Department of Interior, three archeologists have followed Four Corners construction. These men were selected by Dr. Nusbaum but are carried on the Four Corners' payroll.

Their mode of operation is to scout ahead of the ditchers. Usually they can tell by the terrain whether there is apt to be a ruins or structure of archeological value on the right-of-way. When such is found it is uncovered before the ditchers reach the spot, or, if time does not permit this, the line is swung to avoid the location. The archeologists also follow in the wake of the ditchers to search for anything previously overlooked.

At the time this reporter was on the line one discovery had been made that was considered of an unusual nature. In the vicinity of Marsh Pass, Arizona, the remains of a house on top of another house were uncovered. This is believed to represent two historical ages. The area is said to have been a lush agricultural area thickly populated many years ago, then became arid and probably extinct. This was followed by the Pueblo Age, predecessor of the age of the modern Indians. The two houses are relics of these two ages.

A sandstone area where ditching machine had no trouble in cutting the trench.

Stations: Motor Driven Centrifugals

Initially there will be three main line pumping stations, at Red Mesa, Cameron, and Twentynine Palms. This number of stations will give the system a capacity of 70,000 bbl a day at an operating pressure of 1180 psi. Intermediate station sites have been selected and block valves are being installed as a part of the initial construction so these stations can be cut in later with minimum disturbance. The ultimate number of stations will be 14, when

another power increase . . .

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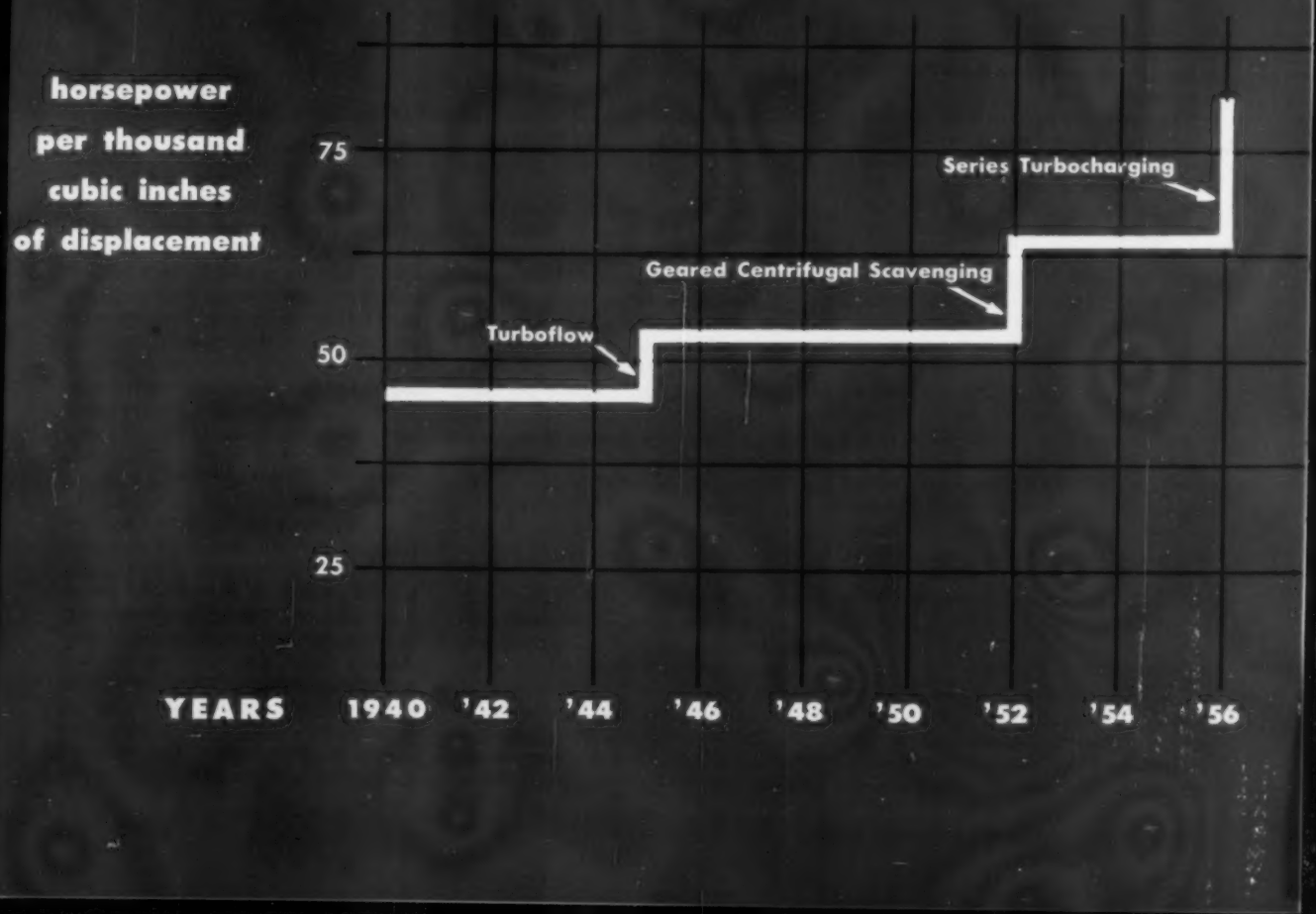
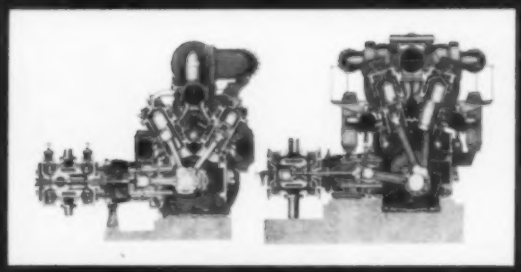


Cross section of Series Turbocharged GMVC V-Angle compressor 720 to 1800 bhp.

Cross section of Series Turbocharged GMWC V-Angle compressor 2000 to 3500 bhp.



The graph opposite tells a story of Cooper-Bessemer developments during recent years that have boosted compressor engine output substantially and thereby saved users countless dollars. Series Turbocharging is the *most recent* . . . and *most significant* in terms of direct advantages and economies.

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Welds were checked for quality by X-ray.

Deep sand here presented a minor problem, but cleaning and priming were accomplished with comparative ease on this level stretch of terrain.

production in the Four Corners area justifies, and capacity then will be approximately 170,000 bbl per day.

Two pressure reducing, or pressure relief, stations will be installed at Kingman, Arizona, and Corona, California, to dissipate hydraulic head build-up where the line makes a substantial drop in elevation, thus keeping pressures within limitations at the lower elevations. Basically, the pressure reducing stations will consist of an arrangement of multiple small size lines through which the oil stream will pass and kinetic pressure lost through friction. Each station also will be provided with a tank into which the stream will dump in case of a mechanical block.

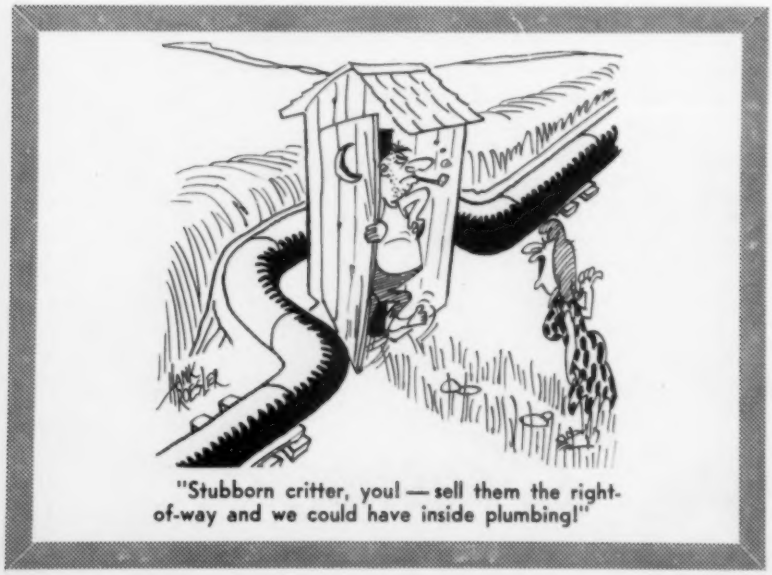
Red Mesa station will have three pumping units consisting of 900-hp motors driving centrifugal pumps at a speed of 3600 rpm. Because it is the initial station on the main line, and will receive oil from several sources, four 55,000-bbl tanks will be provided. Two will be cone roof and two floating roof tanks. Two vertical, 3-stage, 150-hp, deepwell-type pumps will transfer crude from tanks to the suction of the main pumping units.

Equipment at this station will be housed in a steel-frame transite building, but at Cameron and Twentynine Palms pumps and motors will be set on concrete slabs with no covering.

Cameron station will have three pumping units of the same type as Red Mesa. As mentioned, pumps and motors will be in the open, but the switchgear and controls will be in a small building about 100 ft from the pumping units. There will be no tankage.

Twentynine Palms station will have only two pumping units. The pumps are of the same type as at the other two stations, but they will be driven by a 900-hp and a 150-hp (1800 rpm) motor.

Stations will be remotely controlled over a microwave system from the Los Angeles terminal. Red Mesa will probably have operating personnel because crude from Aneth and Bisti feeder lines will be received in tankage at this location, but the other stations will be operated unattended.



"Stubborn critter, you! — sell them the right-of-way and we could have inside plumbing!"

Who Will Take the Crude?

Owner companies, of course, will be the principal recipients of the crude. Connections will be made to Richfield refineries at North Long Beach and Wilmington; to Shell at Wilmington and Dominguez; to Union Oil at Torrance, and to Standard of California at El Segundo.

Construction Office

Four Corners Pipe Line has construction headquarters in Flagstaff, Arizona. J. K. Alfred of Shell is field manager of the construction project. Charley Shell is office manager. In the field, Four Corners has as chief inspectors for the early stages of construction Clint Jarrett, Fred Harmon, and H. I. Payne.

On the eastern end of the system there are only trading posts, and this lack of towns made it necessary for inspectors and construction crews to live in camps, which were moved as the work progressed. ★ ★ ★

SELECTED CORROSION LITERATURE

. . . A Continuing Series

Electrical Insulation of Underground Pipelines

George B. McComb
Consultant
St. Louis, Missouri

PART 2

LITERATURE previously published, and field experiences, indicate there are several reasons why, when cathodic protection is applied, cost to install equipment, power, and maintenance cost, plus amortization, on one line are not comparable with the cost on other lines that have been well protected and laid with reasonable skill or attention to possible damage.

Cathodic protection often has been applied to older pipe systems where coatings have failed or the pipe was bare, but costs were out of proportion to what can be expected when an efficient coating system is used. High costs of maintaining these lines are often justified, however, because costs have increased so much in the last 15 to 20 years that complete reconditioning often would be as expensive as the laying of a new line.

This article and Part 1 deal with the maintenance, or loss of electrical insulation depending on the type of coatings used, in conjunction with planned specifications and coating systems.

The purpose of this series is to report the results of field experiences, test procedures, and test data, and thus help evaluate the specifications and materials that should be used to make a complementary system, like cathodic protection, economical.

Materials carefully selected and properly applied not only will extend the life of the investment but also will materially reduce fixed charges, and the operating and future maintenance costs of complementary protection.

This requires the use of a coating system (coatings, shielding, and reinforcing materials) that provides *electrical insulation* that is waterproof, is immune to soil stresses, soil chemicals or bacterial action of the right-of-way soils—and will maintain a permanent high electrical resistivity so that cathodic protection can be installed, operated, and maintained at the lowest possible cost.

It is anticipated that the data in this series will assist engineers in substantiating their recommendations to top management, and help them and the men who are responsible for future maintenance expenditures to keep costs at the lowest possible level.

There are basically three principal means by which top performance can be obtained:

1. **The purchase of coatings that provide minimum water absorption and will assure good electrical insulation, over a very long period of time — and one that can be properly bonded to the pipe to prevent moisture accumulating between the pipe and the coating system.**
2. **The selection of coating materials that are not affected by soil bacteria or soil chemicals.**
3. **By properly reinforcing and shielding the coatings to prevent soil stress or soil distortion.**

It is assumed that good construction procedures are followed with reasonably good field inspection.

This article will expand on the information contained in the first article of this series — the effect of electrical insulation of moisture penetration or absorption by the basic pipe coatings.

Some investigators have attempted to draw conclusions on the basis of short term tests, in some cases only a three months' test. Experience of the serious investigators who have no product to sell, however, shows an appreciable increase in moisture absorption occurs in the non coal-tar coatings between two and five years, and an increase at approximately the same rate beyond this period, coal-tar enamels absorb much less water and tend to level off, with only a very slight increase, in the 5 to 15-year period of test.

Numerous attempts have been made to relate the loss of electrical insulation value of certain types of protective coatings to soil moisture conditions at the bottom of the ditch, i.e., pipeline level, and with the many tests that have been conducted both by consumer and producer laboratories, under carefully controlled laboratory conditions.

In addition to the amount of moisture found at pipeline level, many engineers are of the opinion that moisture is breathed through non-adhering coatings and condenses on the pipe surface, and that the moisture passes through the non coal-tar types under electro-endosmotic effects. Others believe that the occurrence of moisture in substantial quantities at the pipe surface where the system is cathodically protected, is due to the electrophoretic movement of water to the cathode. This is a common phenomenon and accounts for the soil around anodes drying out and developing a high electrical resistance in cathodic protection installations, for at the anodes water is moved away from the electrode, and any impressed potentials that tend to make the pipe cathodic should, at the same time, insure the motion of water to the cathodic electrode.

Without going into lengthy detail, it is rather well agreed by most pipeline engineers that:

1. With the exception of the Gulf Coast area where soil

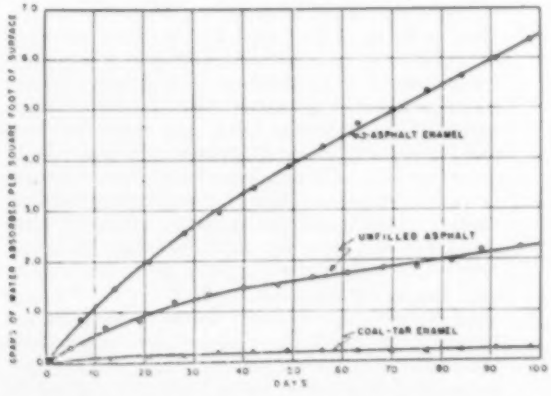


FIG. 1. Results of one of the early authoritative tests on water absorption.

FIG. 2. Boquet Canyon Pipe Line, one of the largest and most unique installations. "In 1957 it was reported to be in perfect condition."[2]

moisture content at pipeline level ranges from 50 percent to saturation,

2. That east of a line at approximately the Mississippi River, the soil moisture content at pipeline levels is substantially constant regardless of rainfall cycles, and ranges from 23 to 65 percent,
3. That west of the line at approximately the Mississippi River and north of a line approximating the north border of Kansas, but not including the Rocky Mountain area, the soil moisture at pipeline level is also substantially constant, regardless of wet and dry seasons, and ranges from 20 to 45 percent,
4. That south of this approximate east and west line (excepting Gulf Coast area) where drought and dust-bowl conditions have been occurring, soil moisture at the 5 to 8-ft pipeline level, also remains constant, but is somewhat lower, generally ranging from 8 to 30 percent,
5. That in the Great Basin and Rocky Mountain areas, due in a large measure to the presence of aggressive soluble salts that have been retained in the soil because of comparatively low rainfalls and inability to drain away through the rivers to the oceans, the soluble chlorides and sulfates in particular cause considerable trouble in moist, or semi-moist soils,
6. That in the more arid regions of the Southwest and Southern California, there is sufficient precipitation for accumulation of moisture in formations having moisture retentive properties such as clays, shales, siltstones, diatomaceous earth, and other soils and rocks composed of finely divided particles; consequently, it is usual to find substantial moisture content in such formations, even at comparatively shallow depths, even though the insulation effect of earth above pipelines does not effect moisture accumulations at the bottom of the pipeline ditch, and may be described as thermal-osmotic effect,
7. That in these areas moisture moves through the soil largely in the vapor phase, and condenses whenever the temperature drops between night and day extremes, and by capillary action tends to travel and remain almost constant at levels below 5 ft, and only the moisture near the surface is evaporated under high day time temperatures. Many soil moisture measurements made in this area at the pipeline level show soil moisture content ranging from 10 to 22 percent, where samples were procured during the hottest and driest period of the year.

Because a substantial part of its investment is underground, the pipeline industry has a better opportunity to control maintenance expense by a careful selection of a protective coating system that will maintain high electrical resistance over long periods of time, thus makes the use or the cost of cathodic protection economical.

The differences in cost when using a good coating and a poor coating system become a substantial amount of money per year, and it is safe to predict that more attention will be paid to this factor of cost than ever before, especially in the face of the constant rise in personnel, material, and operating costs.

FIG. 3. Absorption of water by asphalt and coal-tar enamel shown visually.

In collecting information for this series of articles from many sources, it became quite evident that the different conditions, locale, and management policies, make it impossible to draw a general conclusion as to the differences in economics of cathodic protection and will apply to all systems. The following illustration was selected as representative of how the electrical insulation value of protective coatings effects the cost of cathodic protection, and points up the difference in economics.

Experience of one pipeline company, on 76 miles of 24-in. pipe, indicated that it cost approximately $110 per mile to install complementary cathodic protection to a line that was well insulated electrically with coal-tar enamel, properly shielded with asbestos felt, and inspected, when installed 14 years ago (1943). This company found that the maximum cost to operate per year per mile is $16.21, including:

1. Annual amortization (at rate of 1/12 total cost to install per year).
2. Operating cost, including power, rectifiers, rectifier expense, and replacement of anodes.
3. Maintenance expense, including inspection, labor to replace anodes, ground beds, rectifier parts, etc.

Another pipeline company had 68 miles of 26-in. pipe laid with an asphalt coating and asbestos felt shield. This company found, after 11 years, that the cost to install cathodic protection has increased to approximately $1360 per mile, due to the reduction of its initial electrical resistance.

The minimum cost to operate per year per mile is $284.27, and included:

1. Annual amortization (at rate of 1/10 total cost to install per year).
2. Operating cost, including power.
3. Maintenance expense, including inspection, labor to replace rectifier parts, ground beds, etc.

These examples were selected from many sources, and are typical — some were lower and others higher; however, the ratio of difference is substantially the same.

Fig. 1 was made by Hayes and compares coal-tar enamel with asphalt enamel. This test represents one of the early authoritative tests, which show that the coal-tar enamels have a truly permanent resistance to water absorption or moisture penetration.[1]

Based on these investigations it was determined ". . . that the life of a protective coating was dependent on its resistance to moisture penetration . . ." Twenty-four years later, the performance of the coal-tar enamel justifies this kind of investigation and test work.

"In 1933, the Los Angeles Department of Water and Power was offered the plasticized type of coal-tar enamel for coating the inside of the Boquet Canyon Pipe Line. This line is a steel pipe 96 in. in diameter, supported on piers above ground and exposed to desert sunlight conditions . . . a sample was given to Guy Corfield of Southern California Gas Company for water absorption test . . . he reported that the trend of its water absorption curve followed along the typical coal-tar enamel curve . . ."[1]

The test reported in Part 1, this series, by the Los Angeles Department of Water and Power, is illustrated by Fig. 2, which shows what happens to non coal-tar enamels and the coal-tar enamels available on today's market.

"Fig. 3 picture shows visually absorption of water by asphalt as compared to coal-tar enamel. In the left hand jar (A) is a specimen of asphalt enamel that was originally a 1-in. cube and has been submerged in water for a period of eight years. The middle jar (B) shows a specimen of coal-tar enamel, which was a 1-in. cube and has been submerged in water for a period of eight years. The jar at the right (C) shows a specimen of coal-tar enamel, which was a 1-in. cube and has been submerged in water for a period of 16 years."[2]

In 1943, a series of tests was started in the Wailes-Dove Hermiston laboratories in which 5 by 12 ft steel plates were coated on both sides with enamel. These panels were immersed in water and removed periodically for weighing to determine the amount of water absorbed with time. Unfortunately, these test panels were discarded inadvertently after about two years.

In 1949, the Koppers Company, Inc., who had absorbed Wailes-Dove Hermiston, started a new series of tests in the same laboratories with additional panels being added from time to time. Most of these tests are still being continued at the Koppers Company, Tar Products Division laboratory in Verona, Pennsylvania. These coated test plates were prepared in the following manner:

Five by 12-in. cold rolled steel plates about 100 mils thick were cleaned of oil by washing in xylol and drying with a clean cloth. Occasionally the panels were primed and coated without further preparation. Usually, however, the plates were sandblasted on both sides in such a way that no distortion occurred. The panels were then weighed so that the weight and thickness of coating applied could be determined.

Unless the test plates were to be coated by dipping, they were then primed by brushing on both sides and all edges with the primer specified for the enamel coating to be applied. The primed panels were then placed vertically with contacts at only two small points on the bottom edge and allowed to dry for 24 hours in a well ventilated room at approximately 75 F. Unless a different rate of priming was specified, the amount used was 9 grams per sq ft.

Two different methods of application were used to coat the panels with enamel. In the early work, the panels

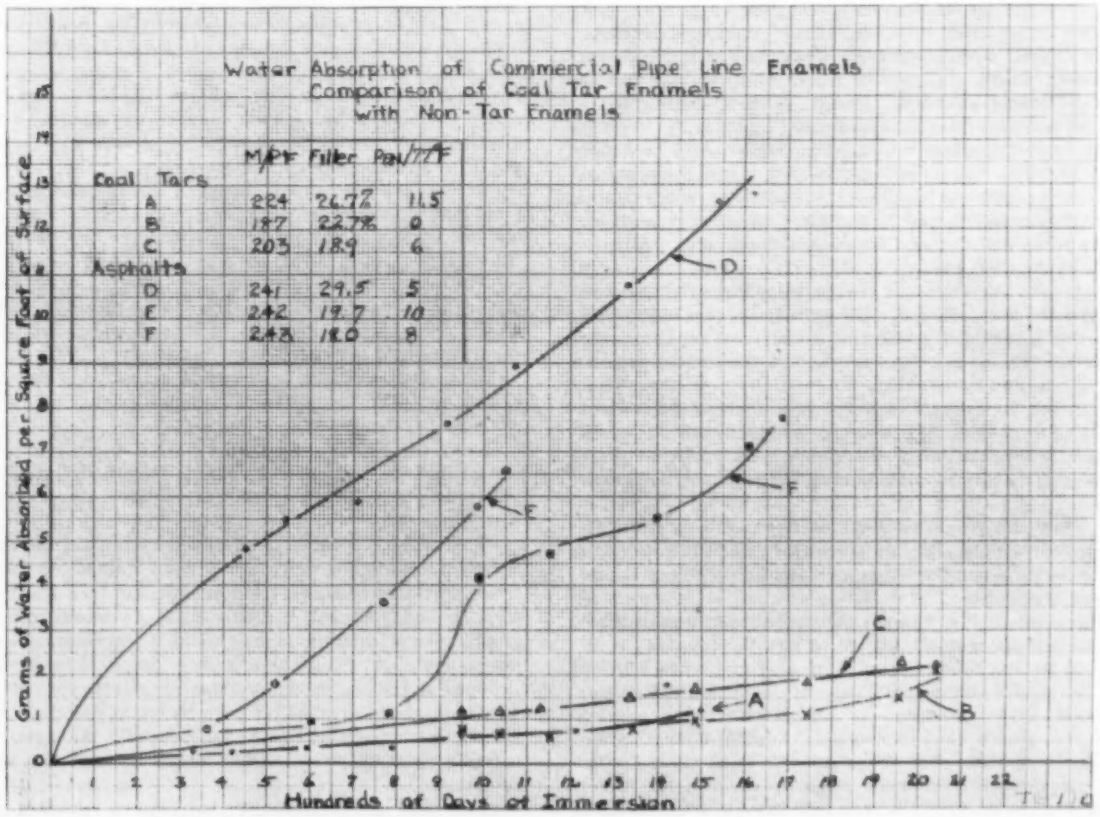


FIG. 4. Water absorption of commercial pipeline enamels. Coal-tar enamels vs non-tar enamels.

FIG. 5. Illustrating how test plates, in measuring electrical resistance coatings, are periodically removed for weighing from a tank in which the water flows gently and is constantly replaced.

were dipped in molten enamel held at a temperature that would give a coating approximately 100 mils thick on each side when the panels gripped at the top edge were slowly withdrawn and then quickly immersed in water. Later the panels were coated by pouring the enamel at the proper temperature to give a thickness of 100 mils over one side of the panel and, after this had cooled, repeating the process on the other side.

With present methods of coating, the edges are wiped dry if the panel has been immersed in water, and the edges then lightly dipped into molten enamel in a shallow pan. Coated panels are then measured and the area of exposed enamel calculated. Finally, the panels are weighed on a sensitive torsion balance used only for this test, to the nearest 0.1 gram before immersing in a tank of water. In this tank, which is kept covered, a small stream of water is constantly admitted at the bottom of one end and overflows at the top of the other. The specimens are placed so that there is a space for the flow of water between adjacent plates.

At periodic intervals, the coated panels are removed from the tank, blotted with a cloth, and any water still visible is removed by blowing a stream of air across the surface. Panels are then weighed on the torsion balance and returned to the tank.

In the beginning, weighings were made at intervals of two to three days. This was later lengthened to one week, then two weeks, then one month, and finally to three months, the approximate interval between weighings now used.

From the weight of the coated panel before immersion, the weight after immersion, and the dimensions of the coated panel, the weight of water absorbed per square foot is calculated.

The graph in Fig. 4 shows the water absorption of three typical asphalt enamels, and three coal-tar enamels, available on today's market. They were all equal when starting out, but even in the first 500 days of immersion the asphalt enamels show variations in performance. One coating started to absorb water immediately. Another sample started up the scale after 300 days, and the third started after 500 days. Coal-tar enamels exhibited uniform low water absorption in the first 500 days, and only a gradual increase thereafter.

After the first 300 to 500 days, the water absorption of the various asphalt enamels follow the regular pattern of all the different tests reported in Parts 1 and 2 of this series, those that were begun as far back as 1930 and those begun in 1952, and in comparison the coal-tar enamels show a continuing uniform low rate of absorption.

A number of investigators have combined the water absorption tests with measurements of the electrical resistance of the coal-tar and asphalt enamels (in Part 3 of this series the earlier tests and procedures will be reviewed). One of the most recent and it is believed the most correct approach has been described as follows:[4]

"The volume resistivity of a material is equivalent to the resistance of a theoretical cube one centimeter on a side. By expressing resistance of substances in terms of volume resistivity, and easy comparison of their relative resistivities can be made.

"Test plates for use as electrodes in this experiment were steel 8-in. by 12-in. by ⅛-in. with supporting rod about 12-in. long welded to them. Plates were entirely coated with the enamels to be tested, except for the upper 6-in. of the supporting stem where electrical contact was made.

"Another plate of similar dimensions made of magnesium metal was used as the other electrode. The electrodes were supported in an electrolyte of distilled water so that the plates did not touch each other or the container. The level of electrolyte just covered the plates leaving a portion of the coated stem above the liquid level. Electrical contact was made between the exposed portions of the electrodes to complete the circuit of the cells. The electrical resistances of the enamels were measured periodically using a 20-million megohmmeter, manufactured by Electronic Industries Ltd., Richmond, England.

"The procedure for measuring the resistance is as follows: The contacts between the electrodes were first disconnected. The 20-million megohmmeter was connected to a 110-a-c voltage source through a Quietone filter. The positive pole of the megohmmeter was then connected to the enamel coated electrode. The negative pole of the megohmmeter was connected to the magnesium electrode. The megohmmeter is constructed such that a constant 85-v output is impressed across the electrodes when the circuit is completed. The resistance is then read directly off the meter scale in megohms. The meter leads were then disconnected and electrical contact again made between the two electrodes.

"The volume resistivities were then computed by multiplying the resistance in ohms by the volume resistivity factor, which is the surface area in square centimeters divided by the thickness of the coating in centimeters."

These tests are based on the scientific fact that the presence of moisture beyond a small amount in the coating will affect its electrical insulation value.

"From the electrical resistivity graphs (Fig. 3) it is observed that the non coal-tar enamels have high initial volume resistivities. However, their resistivities drop off rapidly with time.

"The coal-tar enamels exhibit rather constant electrical resistivities, dropping only slightly from their initial values.

"It is evident that a co-relation exists between water absorption and electrical resistivity data. As noted from the graphs (Fig. 4) that the asphalt enamels absorb more water per square foot of surface and their electrical resistivities dropped at a much faster rate than the coal-tar enamels . . .

"The asphalt and coal-tar enamels tested are those that are commercially available today, and both the water absorption tests and the electrical resistivity tests are being continued."[4]

Laboratory tests of moisture absorption as reviewed here and in Part 1 of this series, were conducted in the majority

FIG. 6. Illustrating the extent and number of samples tested; also the checking and observations of test plates before electrical readings are made.

FIG. 7. Electrical resistance readings are taken every 90 days.

of cases in an effort to relate some of the findings of both laboratory and field tests like those conducted by the American Petroleum Institute.

Scott Ewing commented: "... Some bituminous materials deteriorate more rapidly than others in these tests ... those materials that deteriorate rapidly, readily absorb large amounts of water ... it is also reasonably certain that all bituminous materials absorb some water ... specimens of coal-tar enamel coatings which had remained under continuous field tests during five years exposure to most moist soil, showed an electrical conductance of less than 0.01 micromho per square foot ... most asphalts absorbed greater amounts of water, always showing an appreciable electrical conductance ... the quantity of water absorbed is surprisingly large.

"When moisture penetrates asphalt coatings and reaches the pipe, it produces slight rusting and weakens the bond ... and rusting appears to take place in a period of five years."[5]

Data obtained by H. Walther gives an idea of the extent to which bituminous materials absorb water, indicating the percentage of moisture absorbed by coal-tar coatings was considerably less than that by the asphalts tested.[6]

Other investigators have measured the rate at which bituminous coatings absorb water, using somewhat different methods of preparing specimens, and extending the observations over longer periods. Tests over a period of four years seemed to indicate that the parabolic relation of H. Walther's work applies in the initial stages, but that, as time goes on, the rate of absorption increases with some coatings and becomes constant with others. The most absorbent coatings change in various ways. As the volume of water absorbed increases, the coatings become spongy, or show other peculiar changes that are characteristic of these materials. In any case, this change is described as gradual deterioration, which causes the coating to lose its electrical insulation value.

The performance of coatings that have high moisture absorption factors, is not easily correlated to any single characteristics or property of the soil, but in general the deterioration is more rapid where temperatures are high and the soil moisture content is comparatively low, as found in arid areas. Observations of numerous field tests indicate that either the coal-tar enamels do not deteriorate at all in soils of high or low moisture content, or that they are not influenced by the nature of the soil.

"Progressively beginning with the API and AGA field tests, data have been accumulated of water absorption, and on electrical resistance or electrical conductivity, which obviously are related to the water absorption."[7]

Subsequent parts of this series of articles will deal with:

1. The relationship of soil moistures to water absorption of enamels especially in so-called arid and desert areas, where the amount of moisture is supposed to be low or negligible in ditch bottoms or pipeline levels.
2. The historical and current methods of testing coating systems to determine those that resist soil stress successfully.
3. The effect of bacteria on certain coating systems, in the presence of soil moistures, where temperatures encourage their growth.

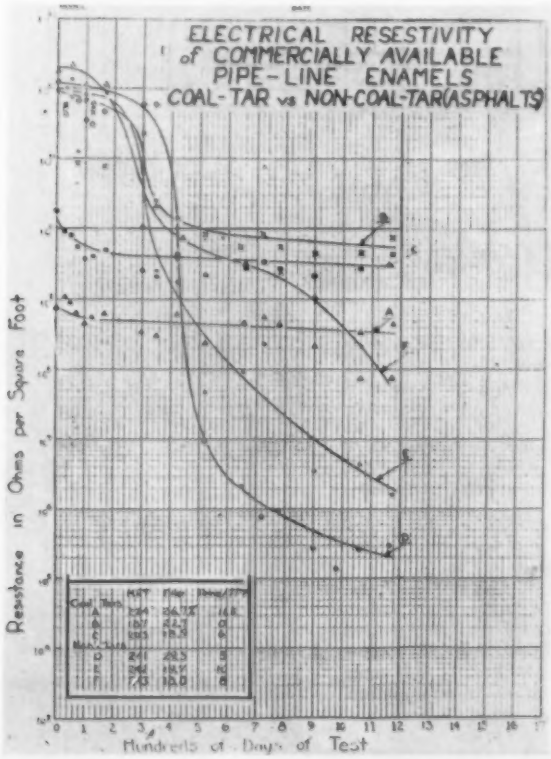


FIG. 8. Electrical resistivity of commercially available pipeline enamels.

References

1. Harry Hayes — "Service Life of Coal-tar Enamel Protective Coatings." Jol. of AWWA. Vol. 10, October 1942.
2. H. Arthur Price 1956 data contained in description of test procedures used by testing laboratory of Los Angeles Department of Water and Power.
3. Report of task force 2 L of the Steel Water Pipe Manufacturers Technical Advisory Committee May 1956.
4. C. U. Pittman — Koppers Company, Inc., Tar Products Division, Technical Section Laboratory.
5. Scott Ewing — "Soil Corrosion and Pipe Line Protection," 1938.
6. H. Walther ... tests conducted in Berlin, Germany, 1938.
7. Erick Larson — "Pipe Corrosion and Coatings," 1938.

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Trans-Canada makes Rapid Strides in 1957

What will be the world's longest gas line completed only 235 miles in 1956, but this year progress has been outstanding — Work will carry over into 1958

Leslie Orr Rowland

CONSTRUCTION of what will ultimately be the world's longest natural gas pipeline got into full swing in the 1957 season with the employment of 12 spreads on main line construction.

Trans-Canada Pipe Lines, Ltd., which is building a 2250-mile line from the Alberta gas fields to eastern Canada, got away to a slow start in the latter part of the summer of 1956 and was able to complete only 235 miles with two spreads before winter freeze-up. Plans for the 1957 season went off on schedule and pipe-laying is now well advanced, with the first 585-mile section of 34-in. pipe completed and delivering gas to the Winnipeg utility company, while other branches are supplying Regina, Brandon, and Portage la Prairie.

Every kind of construction problem that has been encountered on any major pipeline has been met with or will be encountered in the course of laying the Trans-Canada line and its companion link across northern Ontario, the 30-in. line of Northern Ontario Pipe Line Crown Corporation. This part of the line is to be leased to Trans-Canada in the first instance, with option to buy on terms within a fixed time.

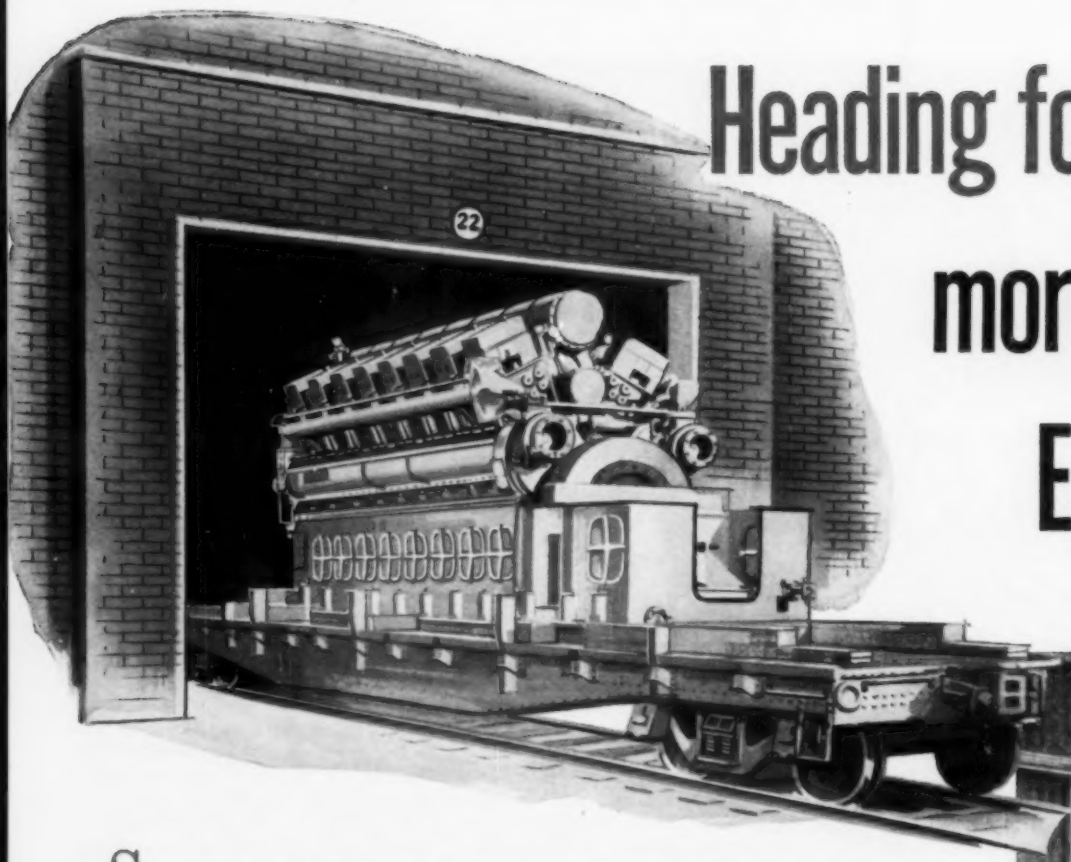
The composite line was designed to follow an all-Canadian route and this resulted in the inclusion of some 200 miles or more of extremely interesting, but also frustrating and time-consuming rock drilling and shooting in igneous granite formations. It also presented one contractor on the privately-owned line with a large quantity of muskeg and one contractor on the Crown line with a similar stretch of this quaking organic material peculiar to northern Ontario, eastern Manitoba, and northern Alberta. The rock work is considered to have made pipelining history, for the amount of heavy equipment involved and for the time required for a given footage of finished ditch.

Construction of the 585 miles of 34-in. line from a point near Burstall on the Alberta-Saskatchewan border to a point 15 miles southeast of Winnipeg at Ile des Chenes, Manitoba, was set up in six sections of approximately equal length. Due to delays in pipe deliveries in the summer of 1956, and particularly to the steel strike in the United States, only sections one and two were completed in the first construction season, and the last few weeks were a nip-and-tuck battle with snow and frost.

Section one comprised 110 miles from the point of origin and was laid by Majestic Contractors, Ltd., of Edmonton with R. L. "Dick" Leonard as spread superintendent. The section crossed the Great Sand Hills near the early part of the job, providing extremely difficult ditching because of the unstable quality of the sand below the surface. Rotary ditchers were able to move across the ground with no trouble, in all weather, as the surface cover of matted grass and roots gave them a good foundation, but as soon as the ditch was cut it began to cave and in some places the width was twice as great as the 6-ft depth when it was finally clammed out to full depth. This portion of the section extended for 20 miles.

The rest of the section was ideal prairie clay, with the intrusion of a few small water holes and patches of gently rolling hills. Through much of this terrain the ditch was cut for as far

Coating and wrapping through the Great Sand Hills of western Saskatchewan. The 34-in. pipe is doped, and wrapped with glass fiber and kraft paper.



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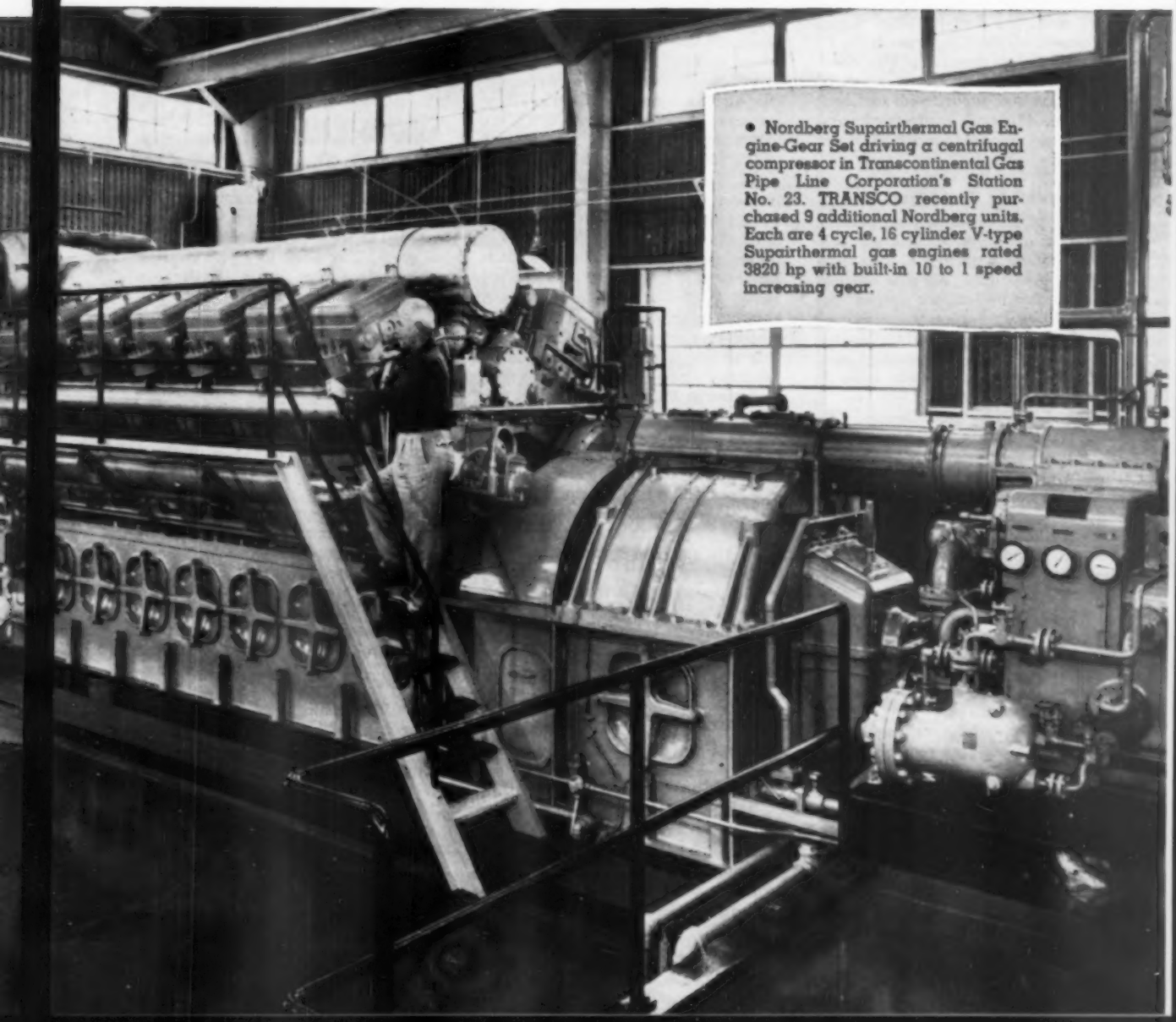
Gas Pipe Line Transmission Costs... more NORDBERG Centrifugal Gas Compressor Sets



• Nordberg Supairthermal Gas Engine-Gear Set driving a centrifugal compressor in Transcontinental Gas Pipe Line Corporation's Station No. 23. TRANSCO recently purchased 9 additional Nordberg units. Each are 4 cycle, 16 cylinder V-type Supairthermal gas engines rated 3820 hp with built-in 10 to 1 speed increasing gear.

River clamps weighing 6000 lb each are being placed on the pipe at Miniota, Manitoba, crossing of the Assiniboine River. The 260-ft section of pipe was double coated and wrapped, protected with shiplap rock shields, and the spaces between weights covered with wooden slats.

Ditching for the Portage la Prairie River crossing. Temperature was at minus 20 F.

as 20 miles ahead of the pipe, during the period of slack pipe deliveries in the early fall. It was found that there was no risk of caving. Nearly all of this section was ditched with two conventional ditchers, leapfrogged, and footage ran to more than 10,000 ft per day with double shifts.

New Welding Technique

While pipe deliveries were coming in at scheduled rates, Majestic was able to lay 52 miles in the first 32 days from kickoff on August 1. All pipe was laid in single joints, but the spread was streamlined by the use on the pipe gang of one of the first experimental models of the double twin-arc welding unit, which arrived on the job early in October.

One of the most interesting and difficult water crossings on the entire western section occurred on section two, contracted to Canadian Bechtel, Ltd., with Ed Kennedy as spread superintendent. This was the crossing of Swift Current Creek, only three miles from the beginning of the 125-mile section. The job was kicked off on July 12 and the creek crossing was put in on July 23. Although the creek is only 100 ft wide it is very swift and runs about 8 ft deep.

To avoid making up a long crossing section in an area where extra space on either approach was very limited, Bechtel walked the entire pipe-laying operation across on a temporary dike bulldozed on the downstream side of the crossing. The pipe gang welded pipe with water swirling around the tops of the tractor treads, and the dope gang wrapped under the same conditions. Finally, with double split-collar reinforced concrete river weights attached on 10-ft centers, the crossing section was lowered in by eight pipelayers, all that were available from the whole spread. The entire lowering-in operation took only two hours, including clamming out the ditch. Ditching was done 14 ft into the creek bed to provide ample cover.

The rest of the Bechtel section consisted of typical central prairie terrain, including portions of level ground, some gently to moderately rolling hills, and quite a number of sloughs and bogs on the eastern portion. Backhoe ditch, through the sloughs, accounted for a fairly small total footage, and two rotary ditchers did most of the cutting. There were only three rail crossings on this section, and one crossing of the blacktop Trans-Canada highway.

Although Majestic mounted its pipe gang equipment on Athey wagons, Bechtel was able to run the entire job with truck-mounted pipe gang units, and in most places even tire chains were not needed.

Both dope gangs were able to cradle almost all pipe directly into the ditch from the catch-off tractor, leaving the slack loops skidded with sand bags over wooden skids in the bottom of the ditch. Tie-ins were kept relatively far apart on both spreads, because of the absence of roads except at the usual prairie region intervals of a mile or two and the small number of water hazards. Considerable bending was required in a few areas of hilly topography.

1957 Construction Program

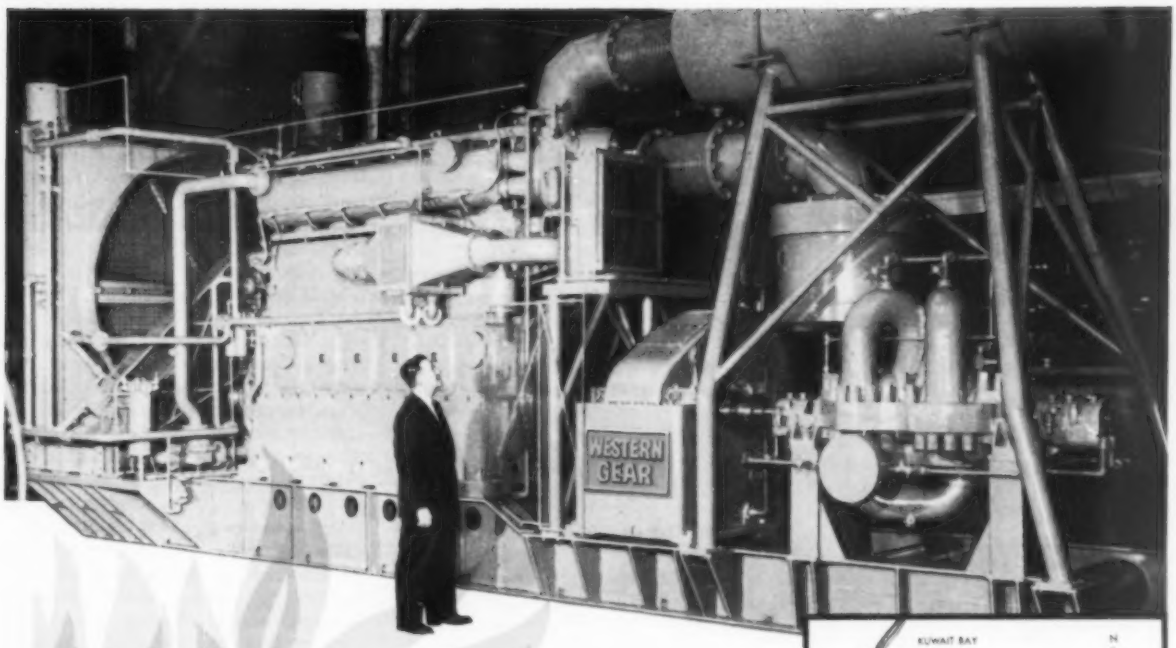
The 1957 construction program actually got under way in early October 1956, when work on the road and rail crossings started on section three, under contract to Universal Pipe Lines, Ltd., of Calgary. This section started at the end of the extended portion of section two, at Milepost 225, and terminated at a point north of Candiac at MP 300.96, for a total of almost 76 miles, all in central-eastern Saskatchewan. Odis Hare was spread superintendent.

The 11 road and rail crossings that had to be bored were all installed before the heavy winter weather set in. This spread also accomplished the only complete winter stringing job, as pipe deliveries came along fast enough to permit the work to be finished in early March. The entire section was strung as single joints and there was practically no damage to the right-of-way from the movement of stringing trucks over the frozen ground.

The absence of any good access roads in this region was an additional factor that made it desirable to finish stringing while travel along the right-of-way was easy. Canadian Parkhill Pipe Stringing, Ltd., of Toronto, did all stringing with its fleet of six trucks, making an average of a mile a day. Bulldozers were used to clear snow from the right-of-way when necessary, but work was facilitated by a fairly open winter with light snow.

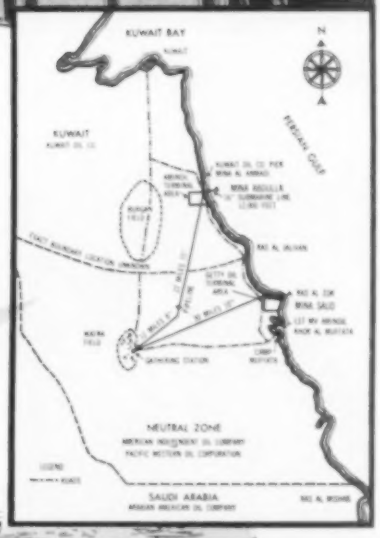
Pipe-laying was kicked off on May 8 and the section was welded out at the end of July and doped out in the first week of August, with all tie-ins completed by the middle of August. All the 1956 records for welding and wrapping were shattered, as the Universal pipe gang welded up to 325 joints, or 13,000 ft, on its best day and the dope gang made a peak record of 16,400 ft, using nine 25-bbl pots. The average day for welding was 11,000 ft.

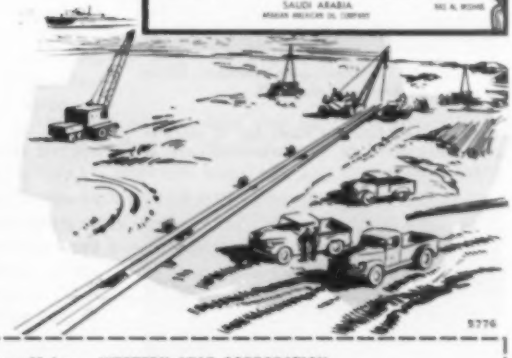
The terrain on this section was not good, as there are a great many small to medium sized bogs and swamps, all of which were full of water from an



WESTERN GEAR high speed units pump Arabian oil in sizzling 130 degrees

Pictured above is one of the four portable pumping units built by Enterprise Engine & Machinery Company, Division of General Metals Corporation, to pump oil for American Independent Oil Company in Kuwait. Western Gear high speed units were selected to boost a 600 RPM input to 3550 RPM output at 4 points along the 35 mile bleak, desert pipeline route.





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Start of pull on first loop of Red River crossing, St. Norbert, Manitoba.

Conventional ditcher with slopers. Ditch holds up perfectly in clay soil.

Ditch in sand-clay soil holds for 10 minutes after ditch is made, then starts to cave as it dries out.

unusually wet spring and early summer rain. About two-thirds of the ditching was done with two rotary ditchers, but a fleet of six backhoes was employed for the rest of the ditch.

For the first few miles, which consisted of level to gently rolling open farm land, a pilot ditcher was used to cut a ditch 4 ft deep through the frost line. Frost was general through the summerfallow ground, as it was able to penetrate through the open soil, but on stubble fields the ground had thawed by the time the ditching started. The pilot ditcher was discontinued when the ditch reached the swamp areas. Ditch was cut a considerable distance ahead of the pipe all the way, because of the large amount of backhoe work, but caving was not much of a problem.

A feature of the pipe gang on this spread was the use of the first air-powered internal line-up clamp to be seen in Canadian operations. It was powered by a compressor and an electric dynamo mounted on a sled towed by one of the new model double twin-arc welding units on the stringer bead crew. It was calculated that this clamp saved up to five minutes' time per joint from the time required to wind up and unwind the hand-operated clamp.

A large quantity of river weights was used on section three, because of the high proportion of water areas. Solid river weighting was done for as much as three miles in a stretch, and several long sections had to be pushed across the deeper bogs and sloughs. Square bolt-on type weights were used, setting on top of the pipe. To speed up transportation of weights from the supply points to where they had to be installed, another special feature of the spread was a double flatbed Athey wagon that was towed by a single tractor and could carry eight of the 6300-lb weights in one load. In spite of some wet weather and some very low ground on parts of the right-of-way and bulldozed access roads, this unit never bogged down.

All units on the spread were mounted on tracks to negotiate the large amount of soft ground, and all the backhoes moved on heavy timber mats, which they picked up from behind and swung around to the front as they advanced.

Bending on this section averaged about 65 to the mile, or almost one bend to every two joints. To speed up welding with the single joints, a double pipe gang was used for part of the time, with six stringer bead welders working three at a time and four hot pass welders in two teams. At the peak of activity, 41 welders were working on the firing line, using individual 200-amp machines on rubber-tired wagons. As the job progressed into the bog areas the firing line was reduced to 21 welders, as the pipe laying started to overtake the ditch, and footage was cut to approximately a mile a day. The pipe gang worked alternate days on pipe laying and tie-in sections, and the dope gang also helped with tie-ins on alternate days, for the last three weeks.

The dope gang equipment included five pipelayers, all of which were needed for cradling through some of the low spots and for handling long tie-in sections. As far as possible the wrapped pipe was cradled into the ditch directly by the catch-off tractor. Slack loops were left at intervals of about half a mile where necessary, but through a large part of the section the extraordinary number of tie-ins and bends for the rolling and boggy topography made slack loops unnecessary.

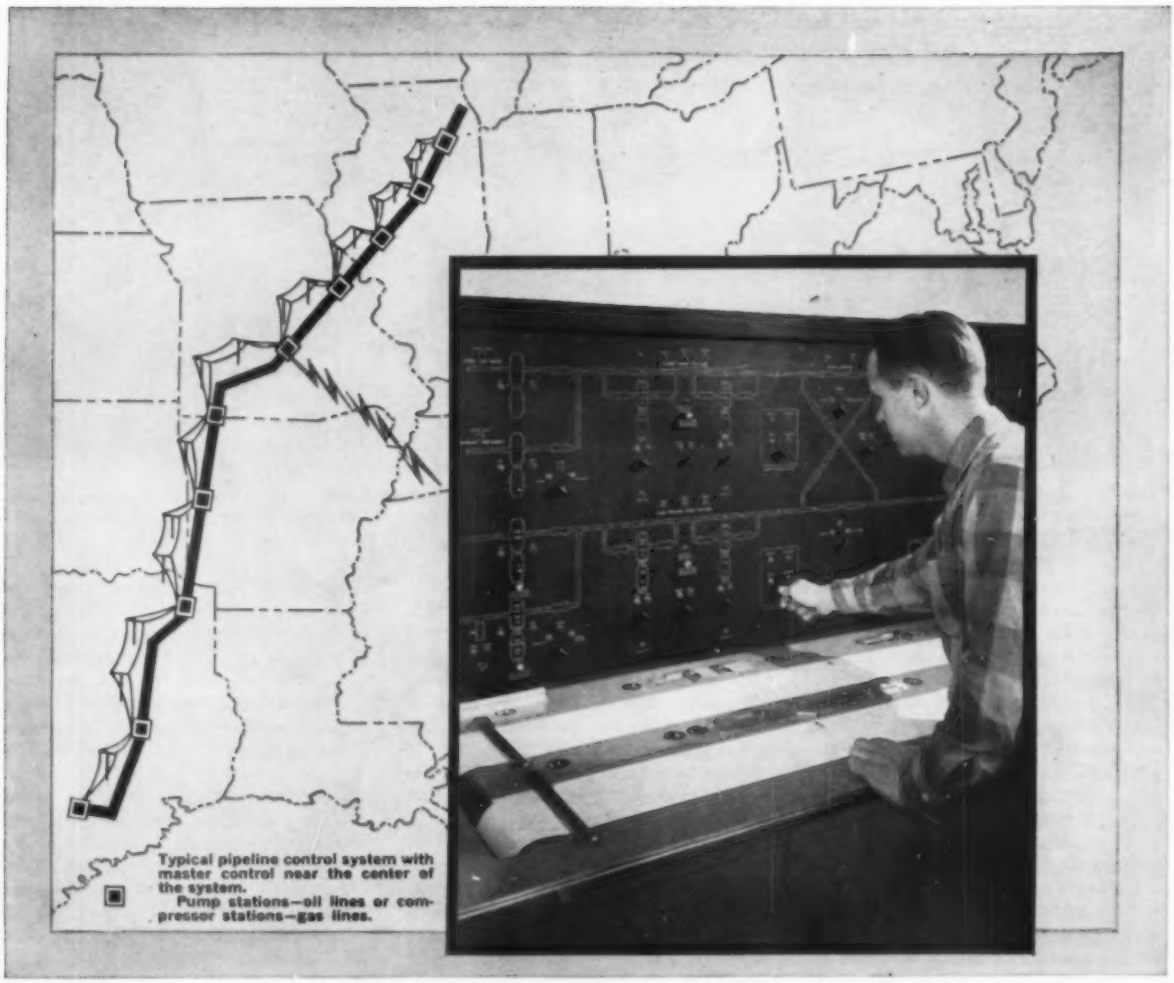
One of the most difficult problems encountered on section three was the handling of tie-in sections through swamps, where in many places the backhoe ditch had to be cut 20 ft wide to get the minimum 6 ft of depth. Nearly all these sections were pushed with the river weights attached. An unusual feature of the conventional ditching was the use of wide slopers, which cut a total width of 10 ft 6 in. for sandy areas and other terrain where caving could be expected, in sand clay or loam. A 41-in. wheel was used on each ditcher, with 48-in. buckets, cutting a 54-in. width in the ditch bottom. Working double 12-hour shifts, each machine could cut between 3000 and 3500 ft of ditch in a day.

Section Four

Similar in terrain was the number four section, under contract to Dutton-Williams Brothers, Ltd., with Thelmer Davis as spread superintendent. The section consisted of 98.51 miles from MP 300.96 at the end of the Universal section to MP 399.47 at the west side of the Assiniboine River Miniota crossing.

Due to a later start of pipe deliveries the spread did not get all its pipe strung in the winter but was fortunate in crossing nearly all the swamp sectors and in particular one of the larger water areas before the spring thaw. Using six of its own trucks, the contractor strung at the rate of 1½ miles per working day and completed 77 miles during the winter, clearing snow with bulldozers on both access roads and right-of-way. Access roads in this section were very similar to those on section three, in being scarce and of poor quality, and most travel was easier on the right-of-way than on the roads.

The pipe was all strung as single joints, but to fill in the period of road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New type welding equipment for double-jointing pipe. Left — Pipe is turned on rubber-surfaced rollers and outside sealer and cover beads applied. A backup clamp inside the pipe prevents burn-throughs.

Right — A specially designed gantry boom, which carries an automatic welding head and an operator, rides inside the pipe.

bans through the month of May the contractor used a small double-jointing gang, which worked on the right-of-way with double welding units mounted on tracks. Ten of these units were used during regular pipe laying on the firing line, feeding 20 welders. Pipe welding was speeded up considerably by this advanced field welding technique, which ran to just about half the section.

The terrain on this section was almost all composed of frequent bogs, swamps, and sloughs, interspersed with stretches of good farm land for short distances. Three ditchers were run, with the lead machine used as a pilot ditcher cutting a 4-ft ditch all the way and the other two leapfrogged behind it to cut the full 6-ft ditch. It was found that the pilot ditcher turned up most of the stray glacial boulders that are scattered along ancient river channels throughout the eastern sector of Saskatchewan. These boulders usually occur close to the surface and the crew of the pilot ditcher dug them out with shovels as they were found. Slopers were used on the regular ditchers, to cut a ditch 88 in. wide with 52-in. buckets.

Backhoes Operate From Steel Trestles

Six backhoes and four clams were employed for the swamps and bogs, and in many places they had to cut a ditch to a width of 20 to 25 ft. To allow for probable slippage from ditch caving, the ditch was cut to 8-ft depth in these areas. For the deeper sloughs a unique method was devised of using a steel trestle on which the backhoe sat to make a cut on each side to a maximum width of 30 ft. The welded trestle was winched by a tow-tractor as the ditch was completed, and maximum footage ran to between 300 and 400 ft per day across water channels up to 700 ft long.

The pipe gang on this spread had conventional 300-amp welding machines mounted on tractors, using three machines for the stringer bead and four for the hot pass. For flexibility the hot pass units were split into two doubles, and this made for additional speed on tie-in sections. A top footage of 12,200 ft was recorded by the pipe gang, but owing to the very slow type of terrain it was felt that this was not a real measure of its potential, especially on the double-jointed portion of the section.

Coating and wrapping came close to setting records for the entire Trans-Canada job, as the dope gang racked up several days of 15,000 ft and averaged more than 10,000 ft per working day. Extensive use of riprap across swampy parts of the right-of-way speeded up movement of all tractors and vehicles and minimized delays due to having to tow or winch machinery out of mud holes.

Tie-in Record Set

The outstanding feature of the Dutton-Williams spread, and probably of the entire 1957 construction season, was the mammoth-sized tie-in gang, which achieved a top day of 21,000 ft of tie-ins through terrain where the average distance between tie-ins was about 1000 ft due to the frequent watercourses. The tie-in gang had ten tractors, including three of the new 572 models and three D8 sidebooms. Two double-welding units were used part of the time and two dope pots. The gang also had a bulldozer, two clams, and two smaller sideboom tractors for handling pumps to pump out water from the ditch.

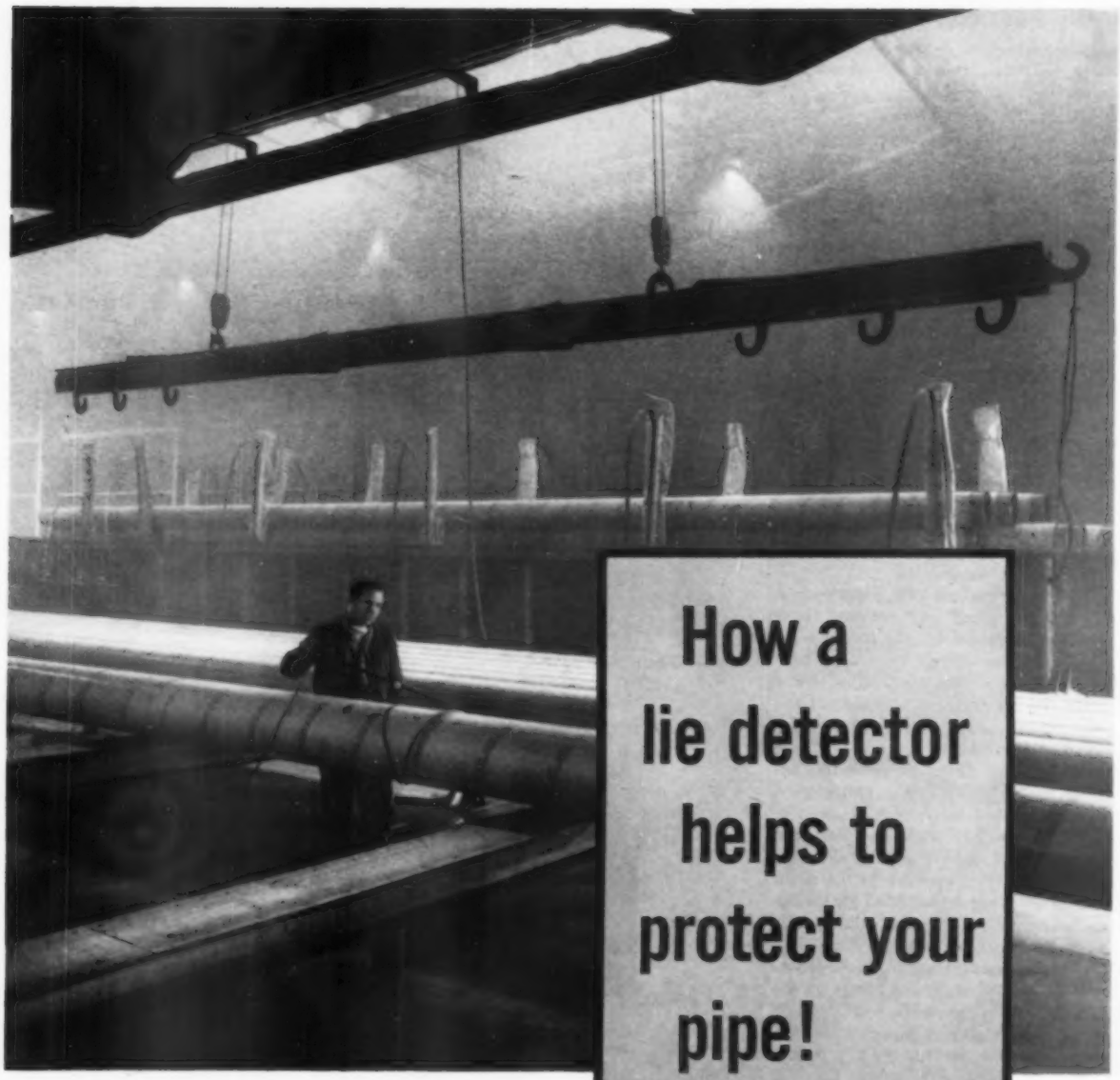
Tie-ins were a colossal job on section four, including one area where 15 miles of pipe were laid as continuous tie-ins across swamps. On one single day, 213 river weights were set on tie-in sections, on 11-ft centers, and it was estimated that the total number of reinforced concrete river weights for the job would run to more than 5000, or approximately 50 to the mile. As many as 200 weights were hung on a single swamp section of pipe. At maximum working speed, the four tie-in welders put in 17 welds in a single day. As far as possible the gang tried to avoid skidding the pipe after welding, and each weld was held with two tractors while the next weld in front was made. Then if the patching was finished the catchoff tractor started to lower in, but if there was any delay the pipe was skidded until the patching could catch up.

The dope gang tried as far as possible to lower in with the catch-off tractor and nearly all pipe was handled this way on straight runs. The long stretches of tie-in sections, however, made it necessary to do a great deal of skidding. Although the right-of-way was rip-rapped across the difficult places, no attempt was made to lay pipe from the riprap in swamp areas, and tie-in sections of as much as 1000 ft in length were made up and skidded for the tie-in gang to lower in or push across.

Section four was welded out at the middle of August and the last tie-ins were completed in the latter half of the month.

Section Five

Not much easier going was experienced on section five, which was contracted to Price-Poole, a joint venture of H. C. Price Company of Canada, Ltd. and Poole Construction Company, Ltd. The section started at MP 399.47, on the east side of the Assiniboine River crossing at Miniota, and ran for 98.62 miles to MP 498.09 at a point five miles west of Macgregor, all in



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Manitoba. The western portion of the section contained a large number of bogs, sloughs, and swamps in heavily rolling farm and bush land. This was followed by about 20 miles of fairly level farm land with numerous watercourses and sloughs, then a stretch of 10 miles across the lesser sand hills in very wild country with no usable access roads, and finally 20 miles of level farm and bush country without many water areas. Clarence Shivel was spread superintendent.

Clamming caved ditch in sand-clay, section 3, ahead of dope.

Ultra-modern pipe gang on section 5. Double twin-arc welder on stringer bead. Air-powered internal line-up clamp.

Long tie-in section for road crossing through swamp.

Automatic Double-Jointing

Because of early pipe deliveries on this section, Price-Poole was able to start early in January on a revolutionary double-jointing operation which paid off handsomely in time saved on the line when pipe laying started in June. All the pipe was stacked at five different locations along the route, and the highly mobile double-jointing yard was set up astride the right-of-way at each point in succession.

The yard, designed by superintendent Barney Elliott and welding foreman Don Barchus, was the most nearly fully automatic operation ever seen in pipe welding. A unique traveling boom facilitated welding on the inside of the pipe. Power supply was generated by a 75-kw generator.

Racks were designed for such extreme portability that the entire yard could be moved to its new location in eight hours. They were also designed for minimum pipe traveling distance from the start of racking to the point where they were delivered to the stringing crane for loading onto the trucks.

Single joints were picked up by a single sideboom tractor from the stockpile and placed in parallel lines on the loading side of the racks, four deep on each side. A walkway was provided between the rows, so that the two operators could work with double beveling machines to bevel a land of 3/16-in. above the mill land on each pipe end, so that the joints could be butted against each other under the welding head with almost the whole pipe diameter of each end flush with the other. The beveling machines were fitted with special axles for the use of the double heads.

The first manual operation was to push the two joints at the head of the line onto the first rack bed. This rack was made up in two parts, on a sliding frame, so that the pipe joints could be moved together from the opposite sides by the use of hydraulic controls operated from the welding head platform. A hydraulic internal line-up clamp was used to line up the joints perfectly flush while a very short tack weld of about 2 to 2½ in. in length was made manually on the bottom of the joints.

The assembled double joint was then centered under the automatic welding head, using hydraulic controls on the racks. The welding head operator then started the head, which mounted a squirt-gun welding machine of the ML-2 type. The pipe was rotated at constant speed under the head, without further attention from the operator, through the use of a central control panel in a truck-trailer at the end of the racks. Rotation was by means of a pair of chain drives operated by small electric motors, with the pipe joints cradled on rubber-surfaced steel rollers on the rack tracks. The mechanism was set to start operating at soon as the welding head made contact with the pipe seam. Rotation speed and heat were both preset and controlled automatically.

Welding electrode was fed through the top of the squirt gun from a spool, and powdered flux was poured into the funnel of the gun, from which it flowed down around the electrode continuously. The excess flux was scraped off by hand by a second operator as the pipe revolved. The butting of the joints with the enlarged lands resulted in 80 percent of the weld being composed of pipe metal and only 20 percent electrode metal, according to statistics compiled by Elliott. It was said to have produced the strongest welds experienced in Price's operations, and there was a clear record of no failures on inspection. Two complete passes were made by the automatic head, a sealer bead followed in continuous succession by the capping bead, without lifting the head from the seam.

The welded double joint was released from this first position by a hydraulic control actuated by merely pushing a lever at the welding head position, and the pipe rolled by gravity along the steel rack flanges to the second position. At this point the single in-

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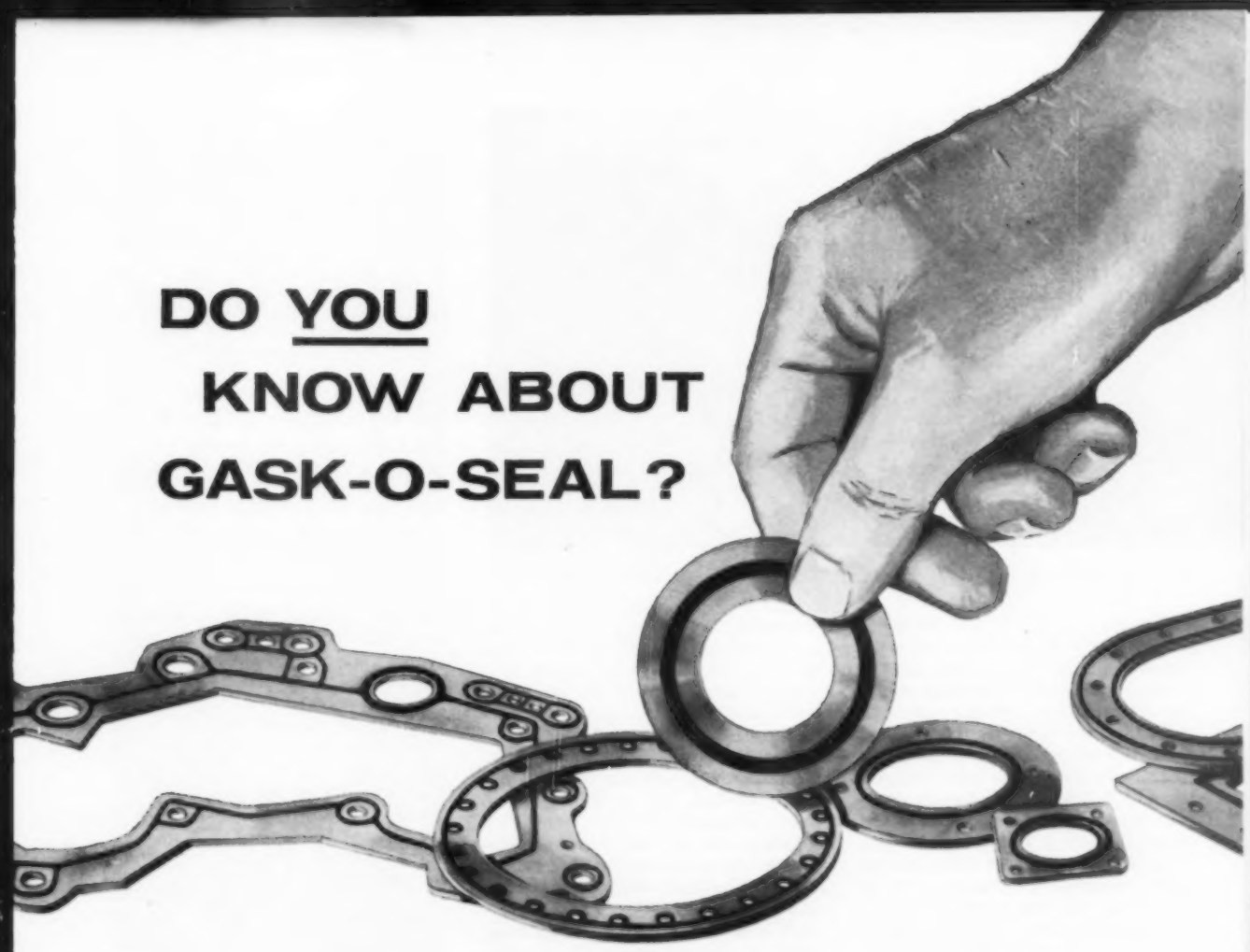

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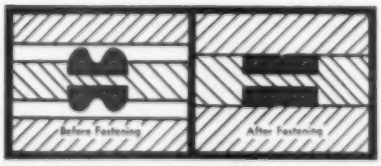

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Typical of small amount of pipe bending required across prairie — section 5.

side weld was applied by another operator, who slid inside the pipe on the sliding boom. The boom was built of airplane metal steel painted with aluminum paint and so rigidly constructed that it was impossible for it to flex and cause any damage to the interior of the pipe. It was mounted on two rubber rollers, which helped to position it inside the joint, and was operated by a set of hand hydraulic controls at the front, where the operator had them conveniently located to both hands as he lay in a prone position facing the front. A strong A-frame structure, partly housed in a ply-wood shelter, provided the support for the boom.

The welding head was another ML-2 type squirt gun, which only had to be positioned over the inside seam by the operator and was then actuated automatically from the main control panel. A small pilot light located beside the head aided the operator in finding the position quickly. The operator's starting of the gun over the welding point, with his hand control, also started the pipe turning on the rubber-faced rollers of the rack. As soon as each inside weld was completed the operator withdrew his boom and the weld was X-rayed by the inspection machine. The double joint was then released by a hand-lever hydraulic control and rolled by gravity down the rack to the third position where it was picked up by the stringing crane.

The average speed of welding in the yard was eight joints per hour, and work was carried on from dawn to dusk, in temperatures which reached as low as minus 40 F in February for a few days, without any preheating. A canvas shield over the first welding head was the only protection for the entire operation, except that the hydraulic control mechanisms were located in a partly heated doghouse alongside the control panel trailer. The three 600-amp welding machines that operated the heads were housed in a row in the trailer, and the generator was also mounted there. A spare generator was carried on a flatbed trailer on the site, but it was never required. No excavation was needed for the racks, as they sat on heavy timber blocks on ground level.

Besides the time saved in line welding, the contractor estimated that there was a substantial saving in the amount of pipe handling, with consequent reduced risk of damage to the pipe ends. Only 20 welders were employed at the peak of pipe laying on the firing line, and line-up work at the front end of the pipe gang was cut roughly by half.

The yard was set up at intervals of approximately 20 miles, and all stringing was done from these locations by Dunn Bros. (Canada) Ltd., using six trucks that averaged about one mile per day. Winter stringing was accomplished for about 35 miles before the spring break-up forced suspension for the road ban period. Further winter work would have saved a great deal of time, as stringing was not completed until the end of July, and, after pipe laying got underway on June 1, the stringing was never more than 10 miles ahead of the pipe. This gap closed as work progressed.

All stringing was done by trucks, with the help of tow-tractors where necessary on hills and across sloughs, except for the stretch across the sand hills, where it was impossible to find bottom on the right-of-way. Pipe for this area was transfererd to Athey wagons and hauled by tractors over the extremely steep grades and soft sand.

Mud Is a Hazard

Mud was the principal hazard to pipe laying for the first month and again in the last week of July and the first part of August. In many places tractors sank to the tops of their tracks and had to be winched out in tandem. In spite of these hazards the spread progressed with both pipe laying and wrapping at an average speed of 8000 ft per day, which was increased to 12,000 ft when the pipe gang reached easier ground. There was a great deal of bending, because of the steep terrain, and the bending gang made an average of 100 bends per day. The pipe gang was equipped with one of the new 572 pipelayers for lining-up, and had a double twin-arc welding unit for the stringer bead, which was set up as a double two-man crew. The hot pass units, four 300-amp welding machines, were mounted on a single tractor and supplied a double two-man crew as well.

Ditching presented no particular problems beyond those encountered on section four. The two rotary ditchers were leapfrogged at two-mile intervals and cut more than half the ditch for the whole section. Slopers were used only in the sand portions, as the ditch stood up very well in the clay soil, which composed a large part of the route. As in the case of all the Trans-Canada spreads, ditch had to be cut a long way ahead of the pipe on many occasions. The ditch was cut 54 in. wide with 44-in. buckets to a depth of 6 ft. Five backhoes were used for water and swamp stretches, working on heavy timber mats, and for pulling stray glacial boulders out of the ditch after the rotary ditchers. The ditchers ran on continuous double 12-hr shifts to make an average of a mile per day each and kept as much as 10 miles ahead of the pipe gang.

Tie-ins were very frequent, averaging 1000 to 1200 ft apart in the first half of the section because of the water areas. Part of the dope gang was usually assigned to work with the tie-in gang. The final tie-in weld was made at the end of August, for a total of exactly three months on the job.

A shorter section, number 6, was contracted to Canadian Bechtel, Ltd., covering 86.75 miles from MP 498.09 to MP 584.84, the termination point for the 34-in. line at Ile des Chenes southeast of Winnipeg. The same spread was used as on section two, under Ed Kennedy as spread superintendent, and mostly the same equipment as in the 1956 season.

Although pipe deliveries started late in the fall, mechanical breakdowns delayed the completion of double-jointing operations, which began in October but were suspended from November until February. All pipe for the section was double jointed, in a semi-automatic yard at two locations. The yard, a con-

ventional Bechtel design, had been set up in 1956 with the intention of double jointing on section two, but pipe deliveries were so slow that only a few miles of double-jointed pipe were turned out.

The Bechtel yard was less mobile than the Price-Poole model, as all the racks had to be sunk in excavated pits. Pipe was picked up from the rail points by Canadian Parkhill Pipe Stringing, Ltd., delivered to the double-jointing yards, and picked up again after the double-jointing operation for stringing on the right-of-way. Only a few miles were strung during the winter, because clearing and grading could not be started until late in the fall and were halted by an early and heavy snowfall in central Manitoba. They were not resumed until the spring and stringing was then held up by the road bans and later by heavy rain, so that the last joint was not on the right-of-way until the middle of July.

The double-jointing yard consisted of a manual operation for the stringer bead and hot pass, with single welding machines being used. The pipe joints were lined up in a row of five or six welding positions, and as each welder finished the double-jointed pipe was rolled by hand along the racks to the next position. Finally, it was rolled onto the automatic welding head rack. This head was a submerged arc model powered by two 600-amp welding machines and using two reels of electrode.

The yard ran into difficulties in cold weather because of the limited efficiency of the hand welding part of the operation, and in stormy weather because of the problems of keeping snow cleared away. During the period that it was running, however, the rate of production was excellent and a maximum of 120 joints were handled in a single day. Double jointing had all been completed by the middle of May and the yard was dismantled and packed up.

Swamps and Bogs

The terrain on this section was reasonably good, with the principal problems those of swamps and bogs which occurred in the first third of the distance. Extensive use of riprap to the full 16 ft of width required to let all vehicles move over it helped greatly to speed up pipe laying as well as stringing, and very little damage was experienced even when the stringing trucks used the riprap with full loads of three double joints.

The longest single swamp section was three miles, near the start of the job, and this was complicated by heavy rain, which turned the right-of-way into a quagmire. For most of this stretch it was not possible to hold a ditch, so ditching was delayed until the dope gang was ready to start across it and the rotary ditcher was then winched directly ahead of the dope gang so that the wrapped pipe could be lowered in by the catchoff tractor before the fresh ditch caved in.

Hanging river weights, section 7; continuous for 15 miles in one stretch on 11-ft centers.

Slopers were used on the two ditchers to cut 7 ft wide at the top. Each machine could dig about 3300 ft of 6-ft ditch on each of two shifts on a good day, and the average ditch footage was 10,000 ft per day. Ditching was kept ahead of the pipe gang all the way, except in the swamp areas, as the rest of the ditch would stand up fairly well. The last 60 miles of the section were along the level ground of the Red River Valley, with its heavy loam soil of high consistency. The only serious hazard was the bogging down of tractors and other vehicles after rain, and at times the whole spread was being winched through the mud with the tops of their tracks level with the ground.

The pipe gang made average footage at a high rate, thanks to the time saving of the double-jointed pipe and the use of an air-powered internal line-up clamp supplied with 180-psi pressure from two compressors. The pipe gang got along with ordinary truck-mounted welding machines, as the dry ground could be traversed as easily with wheeled vehicles as with tractors, and in wet weather tracks would have been little help in the mud.

The stringer bead unit employed three welders, and the hot pass had four working as two teams. The best footage was over 13,000 ft in a day and the average of all working days was over 12,000 ft. Only 18 welders were employed on the firing line because of the double jointing.

The dope gang, with four pipelayers, made up to 12,000 ft in one day and averaged over 10,000 in a normal 10-hr working day. The high spot of difficulty was one bog in which all nine of the heaviest tractors on the spread were cradling pipe and all five clams were packed in between the ditcher and the lead tractor to keep the ditch cleaned out long enough to lower in.

Tie-ins were less frequent than on any of the sections farther west, because the ground was mostly quite level and there were few obstructions except roads. An average of only one tie-in to the mile was needed, and slack loops at intervals of about 2000 ft were lowered in by the tie-in gang each morning before work was resumed on the tie-ins.

The spread kicked off on May 28 and the last tie-in was welded at the end of August.

Introduction to Muskeg

Introduction to the peculiar and unique character of muskeg in eastern Manitoba was experienced with devastating effect on section seven, the first of the 30-in. portion of the line. This was 85 miles starting at the Ile des Chenes terminal of the 34-in. line and ending at the Manitoba-Ontario boundary, under contract to Majestic Contractors, Ltd., with Rusty Killingsworth as spread superintendent. Dick Leonard was promoted during the winter to the newly created position of general superintendent.

The first 15 miles of this section were level farm land in the river valley, consisting mostly of the black loam that was found on section six. Then occurred a stretch of 20 miles of intermingled swamps and sandy clay, followed by a four-mile intrusion of glacial boulders of such large size that they had to be blasted off the right-of-way with dynamite, as they were too big to be handled by backhoes. The next eight miles was solid muskeg, with water on the surface and a depth of as much as 30 ft to solid foundation. This stretch required the placing of 400 reinforced concrete clamp-on river weights to the mile.

Another 15 miles consisted largely of muskeg, with some ordinary swampy ground and a few patches of fairly solid sand clay. The remaining 23 miles were almost solid rock, varying from steep outcrops with vertical walls up to 20 ft high, to rock ledges below the surface and not capable of detection except by stripping overburden with a backhoe. Some of the ledges occurred as far as 5½ ft below the surface, requiring the setting-up of rock drills for the final 6 in. The rock portions were separated in a few places by short intrusions of swamp more than 6 ft deep and by a

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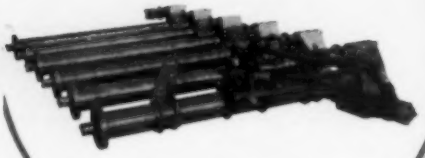

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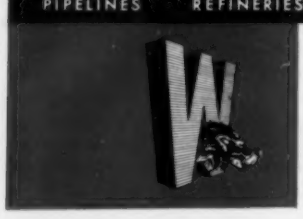

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few portions of sand that could be ditched by backhoes.

Rock Ditch Starts First

As pipe deliveries did not start until the first week in July, the rock ditch was kicked off far in advance at the beginning of May. Jackhammers were used to cut right-of-way where leveling was required, shot holes were drilled on 4-ft centers, and in a few places 100 yards of right-of-way per day was the maximum that could be done. The jackhammers were supplied with compressed air by 600 model compressors. Three sets of twin drills, mounted on tractor booms and powered by 600 model compressors, were used on the rock ditch, with shot holes spaced on 24-in. centers and staggered across the ditch.

Tungsten carbide bits were used on the rock drills, and an average of 40 ft of hole per bit was achieved with double sharpening before scrapping. All the shooting was done in short stretches, mostly with primer cord, and in several cases where the line passed close to summer resort properties the shots were matted with steel cable mats to prevent escape of flying rock fragments. The solid granite rock did not break up uniformly and some pieces pushed off to the side of the right-of-way were as large as a cubic yard.

Timber cut from the right-of-way by the brushing gang was used to riprap extensively through all ground that was unstable, including swamps, bogs, muskeg, and sand clay. A good deal of unstable ground was found without containing water, and the weight of vehicles beat ruts into the topsoil so that all equipment had to be either tracked or towed. However, an unusual stroke of luck with exceptionally dry weather through the muskeg stretches permitted all pipe to be laid from the shallow riprap and not a single joint of pipe had to be pushed through any of the water areas. Cutting the ditch a long time ahead of the pipe also proved effective, as it permitted all the ground water on the right-of-way to drain into the ditch. Although this made it necessary to pump out ahead of the lowering-in, it also ensured a reasonably dry right-of-way for traveling.

Two minor but swift small rivers were crossed by damming the original channel, diverting the flow through a made channel, laying pipe in the bed of the first channel, returning the flow to its original position, backfilling the artificial channel and laying the tie-in section across it.

River Weights in Boggy Areas

More river weights than the originally estimated 8000 were used, as this number was reached in the first 30 miles of swamp and muskeg. The 6400-

lb set-on concrete weights were poured on sites near the right-of-way in a portable plant that made frequent moves to minimize carrying distances. Five flat-bed trucks handled six weights each on each load and were towed with two weights on board along the right-of-way after transferring the other four to two pipelayers, which carried them to the pipe. Large pads of asphaltic material were placed under the weights. Frequency of weights reached as many as 400 per mile maximum.

Stringing through the muskegs and swamps required double handling of the 60-ft factory double-jointed pipe. The stringing trucks loaded up at the rail points and traveled along the blacktop Trans-Canada Highway and up the access trails. At the right-of-way the pipe all had to be transferred by crane to Athey wagons in lots of five joints each and the wagons were towed by tractors along the right-of-way.

Progress was far better than calculated ahead of time, at the rate of one mile per day, and at August 22 the spread had only 22 miles left to weld, 23 miles to dope, and 26 miles to lower in. It was calculated that about 12,000 river weights would complete the job, and estimated completion date for final tie-ins was before the end of September, assuming no worse than normal Manitoba fall weather.

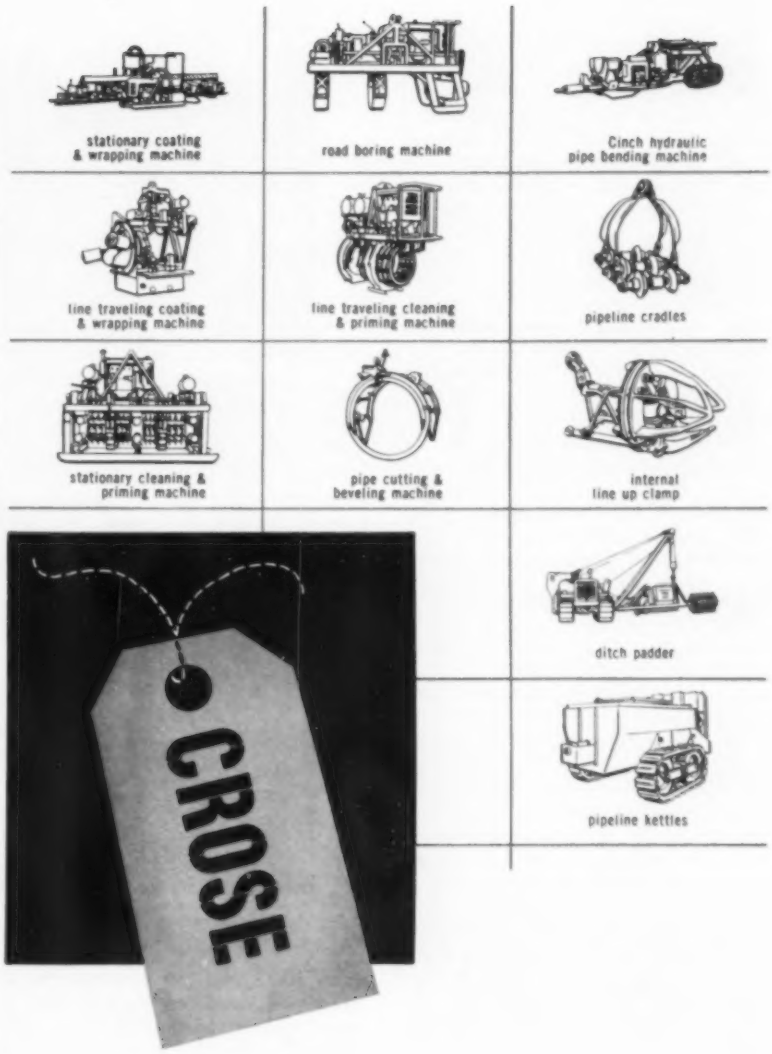
All equipment had to be padded for rock pick-up, including Hi-lifts, backhoes, and draglines. The spread used 12 backhoes, which were able to dig up to 900 or 1000 ft of ditch each per day through swamps and muskeg and worked well on clearing out shot rock. As it was not possible to shoot right-of-way and ditch simultaneously, most of the rock had to be handled twice. Rock pads of hardened steel were welded onto the tractor treads to prolong their life, ase the sharp rock was a severe hazard for steel tracks.

One of the new double twin-arc welders was used on the pipe gang as the stringer bead unit, with three stringer bead welders. Owing to mud conditions in the early and easier terrain, and to the exceptional ground conditions of the rest of the section, it was not possible to make representative footage, and an average of one mile per day was very good for most of the section.

A large proportion of the lowering-in had to be done from skids because of the slow cooling and setting of the asphalt dope, and in all the swamp and sand clay areas the tie-in gang had to use as many as three clams to deepen the ditch, where it had caved in, directly ahead of the lowering-in tractors.

Crown Line

The first section of the Northern



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Ontario line, extending for 57.7 miles from the point of termination of the privately-owned line at the Ontario boundary, has been described as "the section which contains 125 percent rock," and the description seemed like an understatement when the first six miles of finished rock ditch required six weeks to complete. Dutton-Williams Brothers, Ltd., employed a rock ditch gang of more than 200 men for the job, which was kicked off early in June. General superintendent O. R. Mitchell opened up the spread, but Thelmer E. Davis took over as spread superintendent when the spread from section four of the 34-in. line became available at the end of August.

As pipe was only starting to be delivered at this date, no comment can be made on pipe laying except to say that unusual problems would be presented both in stringing and in laying pipe across this terrain of continuous rock outcrops broken only by an occasional watercourse or small swamp. The swamps all lie on rock foundations, which have to be shot, in some cases, to get the last six inches of depth for the ditch.

The gang started with 16 drilling units, mostly twin drills mounted on the sidebooms of tractors and powered by compressors. There were also two jumbo drilling units mounting three drills on hydraulic arms on tractor frames and capable of drilling holes at any angle. Larger compressors were used to power these units, which were used mostly for final grading of right-of-way in the roughest places. A large jackhammer crew of eight men was supplied by one compressor with eight lines.

40 Tons Dynamite Per Mile

Ditch shooting was done with shot holes on 24-in. centers, staggered across the ditch. The suppliers of explosives calculated that the average consumption of dynamite over the entire job was 80,000 lb per mile of finished ditch. The average time for finished ditch to the end of August was almost one week per mile.

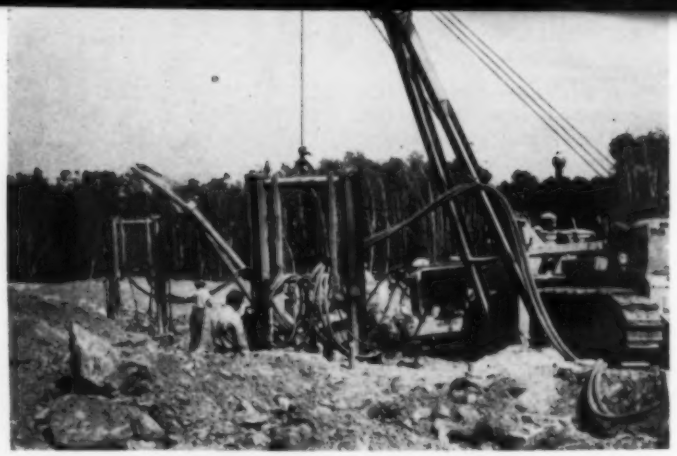
The right-of-way roughly parallels the Trans-Canada hardsurfaced highway, but at many places there are no access roads for distances of five miles or more, and it is not practical to cut shooflies through the rough terrain. Access was made by vehicles along the available trails to the right-of-way and along the grade as far as pickups with 14-in. clearance could travel. From the end of the vehicle routes the men walked as much as a mile to the job, sometimes fording creek channels on log booms.

Probably no other spread has so much heavy earth-moving machinery been seen. Two D9 bulldozers were used continuously on the front end to clear large fragments of shot rock from the right-of-way grade, handling rocks up to about 3 cu yd in size. About 12 D8 bulldozers were employed to clear and grade the rest of the right-of-way, and eight backhoes worked full time to clear shot rock from the ditch.

It is expected that the spread on this section, designated "Schedule A," will be snowed in for the winter before it can finish pipelaying, and that the job will be finished in the spring or summer of 1958.

The other Crown line schedules, which involve less rock but more muskeg, are under contract and kick-off dates were in the latter half of July.

Schedule "B" comprises 94.1 miles, awarded to Morrison Shivers, Ltd., Leaside, Ontario, with field office at Dryden. Schedule "C" is 80.4 miles, awarded to Majestic Nelen, Ltd., with field office at Ignace. Schedule "D" is 78.5 miles, terminating just north of Port Arthur, and has been awarded to Houston Contracting Company with field office at Raith. Work on all these sections was due to be completed some time in the late fall or early winter, with completion dates open and depending on weather and pipe deliveries.



Tough rock drilling on spread "A" of Crown line, northwest Ontario. Maximum cut was 26 ft to level right-of-way to grade.

The only spread using truck-mounts for pipe gang. Stringer bead unit shown.

Trans-Canada River Crossings

Only three major river crossings were involved on the 34-in. portion of the Trans-Canada main line, but due to a combination of weather, ground conditions, and trial and error in planning the construction program they presented unusual difficulties. All were buried crossings and all in Manitoba; two under the Assiniboine River, at Miniota in the western edge of the province, and at Portage la Prairie in the central area, and one under the Red River at St. Norbert in the southeastern sector 14 miles south of Winnipeg. All were contracted to Marine Pipeline and Dredging, Ltd., of Vancouver.

Work started on the first two jobs in the fall, with the intention of having them finished before winter. No test borings were made in the river bed at either location. The same spread was used on both jobs, with the welders and dope gang being moved to the second job as they finished their work on the first.

The same terrain was found on all

three crossings, with a high steep bank on one side of the river and a shallow grade for the approach on the other side. In the case of the Miniota crossing there was a slight overhang on the high side and this crossing was also complicated by having to cross a secondary channel of the river at the same point as the main channel. Although the water level is normally at its seasonal low point in the fall, the 1956 season was so wet that fairly high water persisted right through to freeze-up. Half-inch wall pipe was used.

Great slabs of granite are cleared from right-of-way in eastern Manitoba after hills of rock had been blasted by high explosives. Further blasting was required for the actual ditch, which was 4½ ft deep.

Miniota Crossing

The Miniota crossing was started first. This involved 1200 ft, with twin sections to be laid parallel, 50 ft apart. Ditches were cut with two draglines, using a welded steel sectional barge on the river for one machine while the other worked on the approaches from the shore.

The river bed is almost level at this point and the ditch was cut mostly to a uniform 14 ft depth to provide a minimum 10 ft of cover over the pipe. Clearing and grading started in early September. Pipe was delivered at the end of September and welding was finished within two weeks. Four welders were employed, one on stringer bead, one on hot pass, and two on capping welds.

Coating and wrapping were done with coal-tar enamel, gass fiber inner wrap and kraft paper outer wrap. A conventional dope gang organization was used, with a heavy sideboom tractor for cradling and another for catch-off. Each section was skidded after doping and a layer of rockshield was attached with steel clamps. Split collar river weights of reinforced concrete, weighing one ton to each half, were bolted on at 7-ft centers and the spaces between were packed with wood laths wired together for extra protection.

The first section was pulled across in the middle of November. A miniature railroad was built for the pull, with tracks set on ties in a channel ditched 2 ft into the ground on the shallow grade on the western side of the river. Wheeled dollies were set on the tracks at close intervals, with the intention of giving an assist to the four tractors that were used to handle the pipe. The weight of the section, at 1100 lb per ft gross, proved far too much for the dollies, especially as cold weather had set in before the pull could be made. The forward end of the pipe buckled at one point, due to the weight and the presence of the bend required for the grade up the east bank. This required a re-welding and re-wrapping job and caused a delay of several days. As a result the railroad was abandoned and the second section was pulled, through ice on the surface of the river, without the use of the track and dollies.

The Miniota job was completed at the end of December, as far as pipe laying was concerned, but the freeze-up of the river and the winter snowfall held up the final clean-up until the summer of 1957. The job was completed in early June.

Portage la Prairie Crossing

The clearing and grading crew moved into the Portage la Prairie site in the beginning of October and the job was completed in the middle of August, making this probably the longest river crossing ever laid, in point of total elapsed time.

This crossing was 500 ft long and also involved twin sections. A decision was made at the outset to dredge the ditch in the river bed on the assumption that the sand and silt on the river bottom persisted to depth. It was found after the first 4 ft were dredged that a hardpan ridge lay under the sand and this was not only impossible to dredge but was very difficult to cut even with a backhoe and a dragline. The dredge was withdrawn and a dragline was mounted on the same welded steel pontoon barge.

By the time the experimenting was done, however, the river was freezing over. It was found impossible to continue ditching without the use of dynamite to keep the ice broken, and a second dragline was put to work later to keep the ice out of the river surface channel ahead of the ditching dragline. A great deal of trouble also was encountered in the heavy flow of silt down the river, which tended to fill in the ditch on the deep side of the curve at which the crossing was situated.

The pipe was coated and wrapped and riverweighted exactly the same as for the Miniota crossing, and the first section was pulled successfully on December 15 and settled into the ditch. The section was skidded on heavy timber greased planks set in a V-shape between the rails that had been laid originally for the dollies.

Ditching then began for the second section, but extremely cold weather with temperatures down to minus 40 F made the work very difficult and on several occasions the barge froze solid to the river bottom because of accumulation of ice under it. Ditch was lost several times due to backfilling action of the river current.

The second section was finally pulled at the beginning of April, but before the tie-in welds could be made the river rose so fast with the spring break-up that the machinery and vehicles had to be rushed out to avoid having them swept away. When the crew was able to get back onto the site in June it was found that the section had been carried partly out of the ditch and the entire section had to be pulled out and repaired while the ditch was cleaned out. The final pull was made at the middle of August, with total time on the site amounting to 10½ months.

The net negative buoyancy of the pipe in the river bed is 100 lb per ft. This is considered ample margin of safety for any possible shifting of the river bed during high water and swift flow seasons. Backfill in both cases was accomplished by the natural action of the river except for a preliminary backfill by dragline to cover the pipe in the bottom of the ditch.

C. H. Kincaid started the Portage crossing and Ed Stanley started the Miniota crossing. Hubert Proctor was superintendent in the second stage and completed the Miniota crossing. J. H.

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(Fat) McCartney was superintendent for the completion of the Portage crossing and also finished the St. Norbert crossing.

St. Norbert Crossing

The St. Norbert crossing was started at the end of February with clearing and grading of the site, when the snow was still 3 ft deep on the level. Pipe was strung in the first week of March and welding was completed before the end of the month. Ditching was held up until after the ice had gone out, and did not start until late in April. One dragline was used on the river, working from a welded steel pontoon barge, and a backhoe with a special shop-fabricated 30-ft boom was placed on the shore to dig each approach to full depth. Because of the small rate of flow in the Red, the ditch was cut only to a minimum depth of 10 ft, for 4 ft of cover.

Bad luck was experienced with ditching, as the ditch was lost three times due to erratic action of the river currents in carrying silt into the ditch and causing the upstream side to cave. The pull of the first section was finally accomplished on June 15, requiring nearly two days after the start on the evening of June 13. The ½-in. wall pipe presented a problem of handling, as its thickness and the weight made it almost inflexible. The entire section of 880 ft, of which 500 ft was the distance across the river and the rest of the approaches, was handled by four sideboom tractors. As in the case of the other two crossings, a wire line was run across the river and pulled by a tractor on the opposite side through a pulley anchored to a deadman.

The second section, an exact duplicate of the first, was put in within two weeks, as ditching went remarkably well and there were no hitches at all. In both cases the pipe was not skidded at all but laid directly on the ground and allowed to settle in a few inches just by its dead weight. This settling gouged out a shallow ditch, and when the pull was starting a pump was installed taking suction from the river to pump water to the top of the slope from where it was allowed to run down under the pipe. The water provided enough lubrication to permit the pipe section to slide and assist the pull of the tractors and the wire line. It was the most satisfactory arrangement of all three crossings.

All crossings were put in with the aid of steel drum pontoons, attached to the river weights with 1-in. ropes, to float the sections over the water. The pontoons were cut loose after the pull and salvaged for the next iob. without the loss of a single pontoon. ★ ★ ★

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MATERIAL PROCUREMENT FOR

Compressor Station Construction

Specific requirements by the project engineer will cut both purchasing and construction time

Craig C. Lazzari
Fish Engineering Corporation

Purchasing practices and time required may vary depending on economic conditions and especially military requirements. As the delivery of major items in an industry is relative, however, a change in the availability of one article is soon reflected in the availablility of all equipment. The sequence of purchasing outlined below will not vary appreciably. — Author's note.

No transmission line or compressor station can be successfully built without well planned scheduling. Engineering skill is of no avail unless a definite purchasing and expediting schedule is established and followed.

A schedule must be set up to purchase and expedite compressor station material so that materials will arrive on the jobsite coordinated with construction requirements. In short, men and materials must be in the right place at the right time to avoid time and money consuming delays.

The responsibility for scheduling the material is placed on the purchasing department; however, without the close cooperation of the engineering, drafting, and construction departments, the buyer can do little to expedite purchasing. This discussion purposely omits the engineering, design, and construction problems of building a compressor station and concentrates solely on procurement.

The main duty of a purchasing department is to seek competitive quotations and order material so that it will arrive on the jobsite in a predicted pattern.

SEQUENCE FOR MATERIAL PURCHASING

Under normal conditions, materials should be ordered in this sequence:

1. Compressors.
2. Auxiliary generators.
3. Heat Exchangers.
4. Buildings.
5. Pipe, valves, and fittings.
6. Vessels.
7. Electrical.
8. Pumps.
9. Starting air compressors.
10. Miscellaneous items.
11. Concrete.
12. Soil tests, water wells.
13. Fence.
14. Boilers.
15. Machine tools.
16. Instruments and controls.
17. Paint.
18. Insulation.

ORDER OF ARRIVAL

The equipment should be expedited to arrive at the jobsite in the following order.

1. Soil tests.
2. Water wells, temporary water piping, and well pump.
3. Fence.
4. Cement, reinforcing steel, form lumber, grounding wire, sand, and gravel.
5. Building to be used as construction shack and warehouse.
6. Floor drains, compressor mat drain piping, anchor bolts, and leak strip.
7. Compressor block anchor bolts and sleeves, free air piping for blocks, floor beam bearing plates, random lengths of trench angle.
8. Basement wall door and window frames, compressor building anchor bolts, compressor floor beams (or decking), and pipe sleeves.

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Without Ground Wire, for Use on Transmission Lines.

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It rings the bell for simplicity too. Because it uses a new-principle, double electrode, pad or "saddle,"* it maintains a constant inspection voltage of 12,000 to 15,000 volts on the pipeline at all times and no trailing ground wire is needed. Weather and soil conditions do not affect its operation. No generator is needed as the detector carries its own 3-cell, storage battery in a shock resistant Royalite case resting on a phenolic plastic base. It does not utilize a "hot" spark which can damage coatings.

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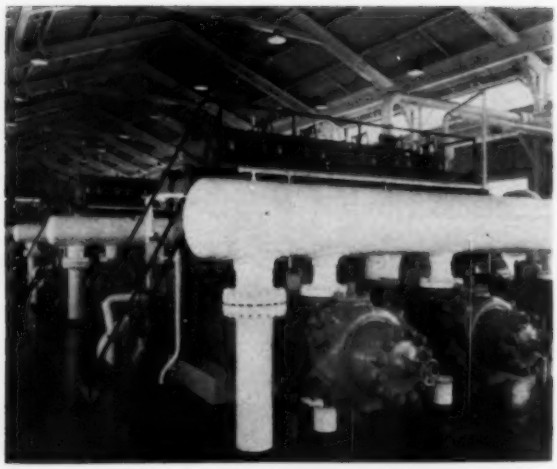


Engines from compressor end.

9. Auxiliary generator engine anchor bolts and sleeves, cooling tower anchor bolts, and anchor bolts for various tanks and structures.
10. Large diameter thin wall pipe for water service. Pipe primer, enamel, and felt. Compressors and compressor cylinders, compressor suction and discharge bottles.
11. Auxiliary building anchor bolts; office, warehouse and shop building anchor bolts. Electrical conduit and cable.
12. Compressor building, compressor building floor plates, cooling tower, pipe pier anchor bolts.
13. Large diameter heavy wall pipe for gas service. Paint primer, pumps, jacket water cooler, gas coolers, fuel gas heater compressor engine oil coolers (usually with compressors), auxiliary engine oil coolers (usually with auxiliary engine), pipe, valves, and fittings, tile sewage pipe (field purchased).
14. Auxiliary building, air compressors, instrument boards, electrical fixtures and lighting standard, electric motor starter equipment, pipe, valves, and fittings.
15. Engine mufflers, engine oil and air filters, miscellaneous pressure vessels; tanks and structures; pipe, valves, and fittings.
16. Walkways, crossovers, grating, railing, pipe clamps, miscellaneous floor plate, pipe, valves, and fittings.
17. Instruments and controls, boiler, unit heaters, steam traps, paint, machine shop equipment, change room fixtures (field purchased), and insulation.

PURCHASING RESPONSIBILITIES

Responsibilities of the individual buyer are many. He should be in constant contact with the suppliers and be fully informed on price and delivery charges. The buyer should be endowed with good judgment to weigh the price of an object against delivery, for it is not always the cheaper products that reduce the cost of a project. Other intangible assets the buyer should possess are ingenuity and imagination, for often certain changes and substitutions can be made to hasten deliveries and thus cut construction costs. A further responsibility of the buyer should be to assist in expediting. As he is expected to give the supplier repeat orders, the buyer is in a much more advantageous position to make demands than the expediter, who may be connected with purchasing.

Drafting costs can be cut considerably if certified drawings of the equipment are available promptly; therefore, the buyer should know the order in which it is necessary to stipulate delivery of the material. Manufacturer's drawings of equipment such as main compressors, air compressors, auxilairy generator units, electrical switchboard, pumps, cooling tower, and heat exchanger equipment are needed for layout studies and preliminary takeoffs.

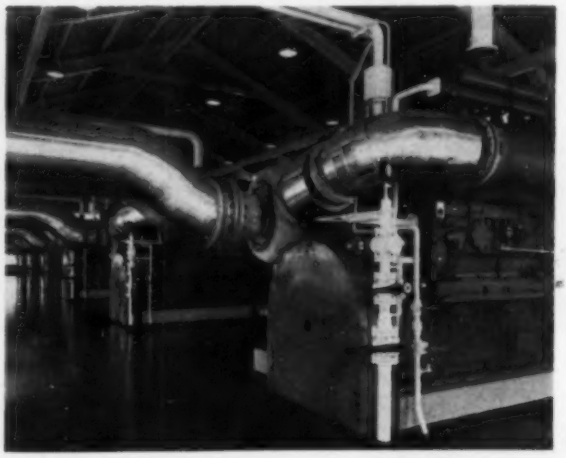
Certified drawings of the piping and foundation will be needed by the drafting department and every effort should be made to obtain them as early as possible.

Purchase orders should be as complete as possible, for the purchase order has a greater distribution than any other instrument, including the plant drawings, and it should be used to disseminate information. Long after the job is completed, the purchase order will be used as a reference by the purchasing and the engineering departments, as well as by the station superintendent. If a plant expansion is a possibility, then the necessity of a completely written order is even more important because of the need for duplication of material. Then, too, a well written purchase order helps the field material man in submitting an accurate receiving report.

COMPRESSORS

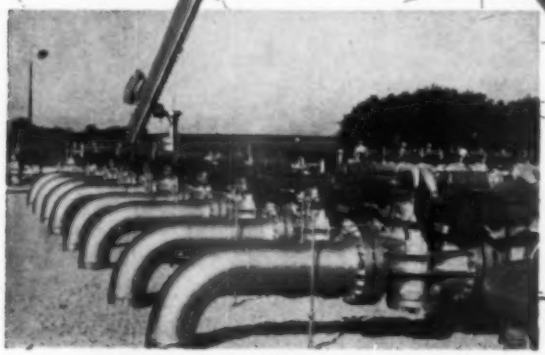
In purchasing the material for a compressor station, the first thought is usually given to the compressors. There are important items that, if taken into consideration initially, will save time and avoid revisions during later stages of design and construction.

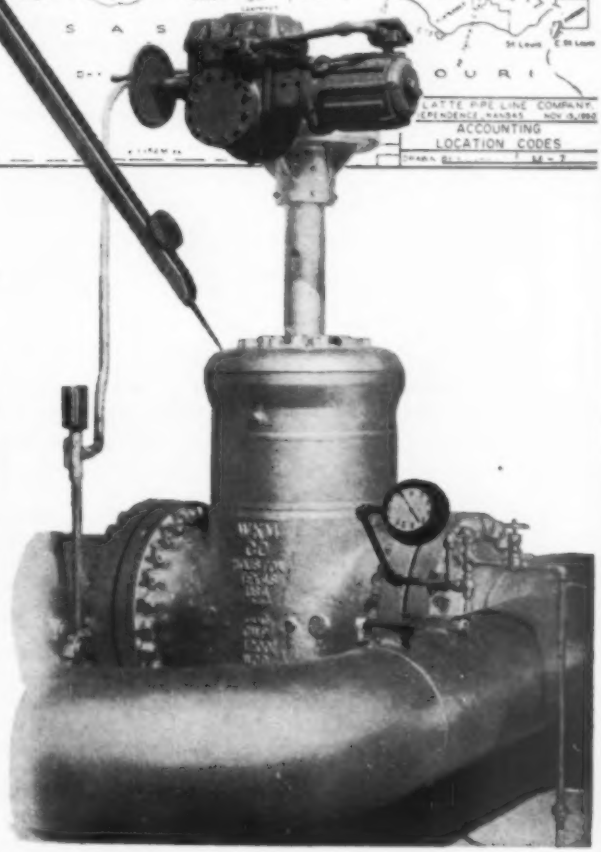
A list of standard appurtenances as well as special items should be well defined in the order. The type of ignition, quality of compressor rods, piston rings, and specifications of compressor valves should be included, even though they have no particular influence on compressor station design. The type of fly-wheel guard should be specified if it is to be purchased from the compressor manufacturer. The suction bottle supports definitely should be included if the compressor bottle sizes have been computed. Usually the main anchor bolts are supplied with the compressors. Specific instructions should be given to the vendor as to when and where the anchor bolts are to be shipped. The compressor oil cooler should be selected. It may be purchased as a separate item; however, most compressor manufacturers are in the heat exchange equipment business and offer competitive prices.



Engines from flywheel end.

1,075 Controlled Miles





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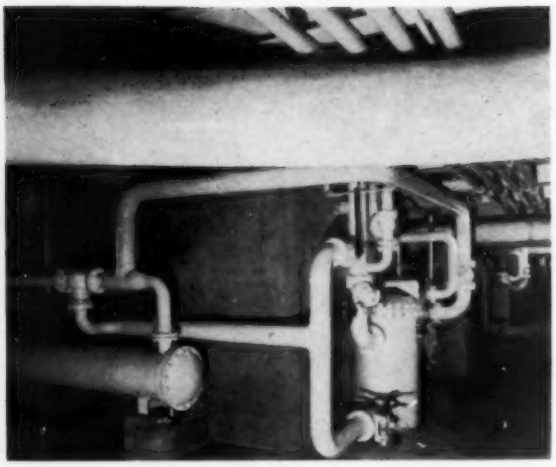


Oil filter and heat exchanger.

While concentrating on the compressor purchase, the following data required by the various design departments should be obtained:

1. Heat dissipation rates of engine jacket, compressor jacket, and lube oil.
2. Jacket water temperatures in and out of engine.
3. Oil temperatures in and out of engine.
4. Oil circulation rate and oil pressure.
5. Maximum guaranteed fuel consumption and required fuel gas pressure, maximum upstream and downstream of regulator.
6. Oil capacity of crankcase.
7. Pressure drop across shell and tubes of oil cooler and engine, and compressor jackets at specified flow.
8. If the compressors are to be supplied with an individual jacket water pump, obtain pump curve.

Special equipment such as mufflers, air filters, and oil filters, though not critical at this stage, should be purchased. They may be obtained from the compressor manufacturer; however, a contractor usually pays more for the equipment purchased through an intermediate, and sacrifices expediency by introducing an extra party into the transaction. The mufflers, especially, are subject to revision as the design of the station progresses. It is best to place the units on order separately with the understanding that the material is to be provided, but fabrication is not to begin until shop prints have been submitted and returned "Approved for Construction."

Generally speaking, the mufflers will be mounted outside the compressor building in a vertical position supported either by a skirt or steel structure. The only problem, then, besides the selection of a muffler with proper acoustical qualities, is to correctly specify a bottom inlet, a low-side inlet, or a high-side inlet.

The oil filter usually bears no revision and may be placed on order for immediate delivery. The compressor manufacturer should be consulted on the selection of the oil filter, however. Air filters usually do not require changes, but, if continuous curtain type oil bath filters are ordered there is the possibility that the inlet opening will need to be raised or lowered. So, if the units are ordered considerably in advance, the purchaser should protect himself by stating that the opening is not to be cut until the vendor is notified.

If the driving mechanism for a curtain type air filter is specified "explosion-proof," its delivery usually is longer than the air filter itself. In such a case the manufacturer should be advised to make shipment of the filters so that it may be set in place and connected. The electrical gear can be mounted at a later date.

AUXILIARY UNITS

The purchase of the auxiliary units is about as complex as that of the compressors, for the same general information will be needed. Though such items as mufflers, oil filters, air filters, back-fire relief valves, oil cooler, etc., do not usually have long deliveries, they should be ordered at this time. Such pertinent data as heat dissipation rates, water and oil temperature operating pressures, and pressure drops, should be acquired, as well as fuel gas pressures. Fly-wheel guards and guards for the exciter belt drive should be considered for purchase. The oil coolers, as in the case of compressors, may be ordered with the engine. The selection of a muffler is facilitated in that a standard bottom inlet muffler is used in practically every case whether it is mounted vertically or horizontally.

Atmospheric coolers.

HEAT EXCHANGERS

The cooling equipment, such as cooling tower, jacket water coolers, gas coolers, fuel gas heater, etc., should be processed as soon as possible. There is nothing to delay purchase after the cooling system has been decided upon. Again, the buyer is urged to include as much of the design data on the order as possible.

When air coolers are required, the safety department might consider the installation of a fence to protect personnel and ladders and platforms to facilitate servicing and inspection. Shell and tube units can, of course, be purchased with the least trouble because of their simplicity, although it is well to remember that the size and orientation of nozzles are seldom acceptable without revision.

Another point to remember is that some states, such as Pennsylvania, require that the heat exchangers be built according to code even though they are in low-pressure service.

Usually brass tube sheets and admiralty tubes are specified for water exchangers. Both items usually carry long mill deliveries and the purchaser is urged to investigate substitutes if better shipments are needed. Bronze-clad tube sheets usually can be obtained in a fraction of the time

required for the solid brass tube sheets, so, if the fabricator's delivery promise is not suitable, it is suggested that the specifications be changed. If atmospheric type jacket water coolers are employed, an attempt should be made to establish the number and size immediately so that the cooling tower can be purchased with a properly sized coil shed.

Jacket water coolers for individual engines.

COOLING TOWERS

A cooling tower is a major piece of equipment made up of many component parts purchased separately and supplied as a package unit by the tower vendor. Cooling tower delivery is generally reliable and seldom delays work at the jobsite. In purchasing a cooling tower a decision should be reached on such items as whether to get a ladder or a stairway, the size and number of water headers, and who is to erect the tower. The choice between ladder and stairway is one to be settled by the safety department. The size and number of headers will aid the material department in making an accurate piping takeoff. In some instances purchases are made of both material and erection, whereas in others only material is bought. Still in others, depending upon the construction schedule and other variables, only the supervision of erection may be contracted. The anchor bolts, galvanized or bronze, should be purchased at this time, separately or through the cooling tower manufacturer. If the anchor bolts are purchased with the cooling tower, the purchase order should specify when and where they are to be shipped. Again, it is imperative that certified drawings be obtained as soon as possible.

BUILDINGS

Before the buildings can be designed, the size and number of items housed therein must be known. The preceding sequence of purchase is arranged, therefore, not only from the standpoint of field requirements, but to establish all the physical data required with which to design the buildings. The buildings may be designed and constructed by the contractor; however, usually they are specified by the contractor and designed and erected by a building manufacturer.

If the building is purchased erected, the purchasing department should obtain a separate price for the material. This practice is recommended for the purchase of any other item that involves labor, such as the cooling tower, since a breakdown is necessary for accounting purposes.

Such items as traveling crane and hoist should be placed on order immediately so that they will arrive on the job with the building and be used to move equipment during construction. The anchor bolts may or may not be ordered with the building; however, they should be considered critical and should be shipped to the job as soon as possible.

Some building manufacturers do not supply the glass for windows, and if this is the practice, a complete takeoff should be made and the glass placed on separate order.

If arrangements can be made, the smaller buildings, such as office and/or warehouse building, should be purchased to arrive on the job as construction is begun. The building can then be used for temporary storage of material. Bins may be erected therein and such articles as pipe fittings, small tools, nails, bolts, etc., can be housed along with valves and other equipment.

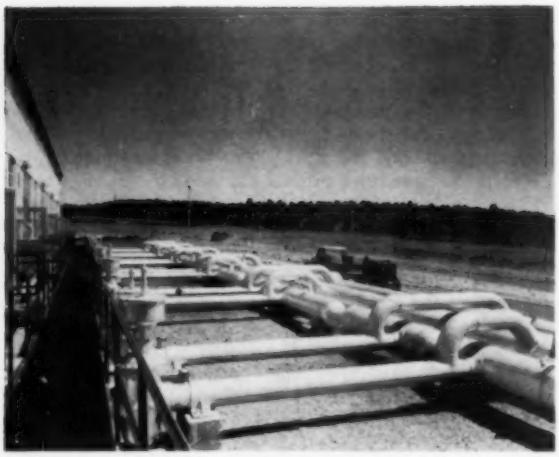
A great deal of time may be lost by waiting for the drafting department to provide finished drawings of buildings to submit for quotation. If a building is to be purchased fabricated, time can be saved by merely writing the specifications covering the siding, windows, doors, ventilators, gutters and downspouts, frames, hoists, fastening methods, etc., only the size of the main members, location of doors and windows, and eave details are necessary on these drawings. In most cases, too, much detail is included in the building drawings that are later supplemented by detailed vendor's drawings. Usually, the main columns bear the longest mill delivery, and the object is to enter the order as soon as possible even though subsequent changes in the arrangement of the building have to be made.

Piping in compressor station basement.

PIPE, VALVES, FITTINGS

The engineering department should be in a position to provide the purchasing department with the size and specifications of pipe within two weeks after material purchase has begun. A delay in ordering the large, high-pressure valves and pipe can create a serious bottleneck in the construction program. If pipe size and thickness are not definitely established, a tonnage order should be entered. The pipe mills schedule orders on a tonnage basis and do not usually require sizes and weights prior to a month and a half before rolling.

A piping plan should be drawn so that most of the large welding fittings may be included in a preliminary bill of material. The valve may be taken off the mechanical flow sheet. The material takeoff department should supply the purchasing department with a preliminary bill of materials of pipe, valves, and fittings no later than three weeks after the purchasing of material has begun. This can be done with a certain degree of accuracy only if the purchasing



Manifold piping, suction and discharge valves.

department is able to obtain preliminary or certified prints on the heavy equipment, as mentioned previously.

Pipe material for a temporary water line is required on the job at the very beginning of construction. If it is possible to install a permanent water line, then additional material such as pipe primer, enamel, and wrapping, should be sent to the field.

VESSELS

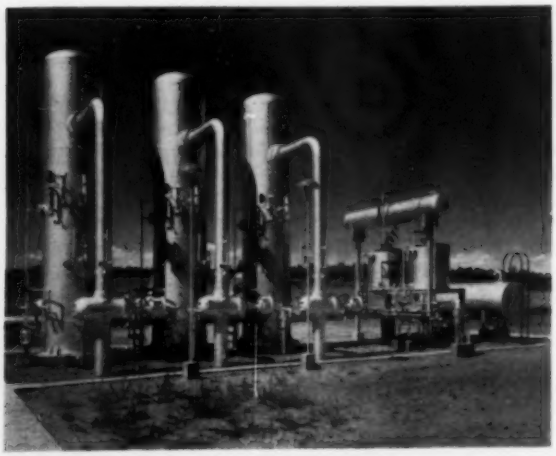
The vessels usually found in a compressor station are: Dust scrubbers, scrubber charge tank, scrubber settling tanks, scrubber oil storage, lube oil storage, jacket water surge tank, interstage separator, air storage tanks, compressor suction and discharge bottles, and water storage tank.

Of this group the correct sequence is to order the scrubbers first. Such information as the capacity, design pressure, design code, and minimum working pressure required for sizing the units may be established through the main gas compressor sizing data.

The purchasing department can avoid the responsibility of selecting the proper code by placing that responsibility upon the vessel manufacturer, who is usually well informed on all state code requirements. This also applies to the other pressure vessels such as scrubber charge tank and the air tanks, although the latter are usually designed according to ASME code. As most stations operate at high pressure, and the ASME code applies, the scrubber charge tank should be ordered immediately. The cylinder for this vessel is usually so small in diameter and the thickness so great that considerable difficulty is encountered in rolling and consequently a long delivery ensues.

The starting air tanks usually are readily acquired. The speed of a purchase is accelerated if the vessel department standardizes on a given diameter or capacity and varies only the number installed, depending upon compressor horsepower. The rest of the vessels, with the exception of the compressor bottles, have a reasonably short delivery because they are usually made of ¼-in. or lighter plate. Such items as target, target float, and gage rod should be purchased along with the respective tanks. As the lube oil and scrubber oil storage tanks are elevated, the structural support should be purchased at this time. The charge tank structural support also should be placed on order so that it will arrive on the site ahead of the charge and settling tanks.

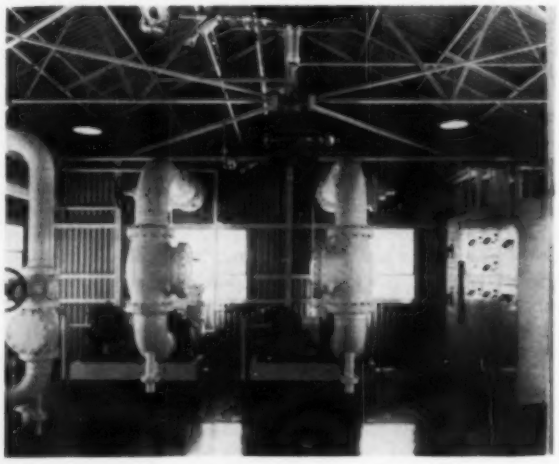
The compressor suction and discharge bottles are listed as vessels but may be considered prefabricated piping as they are usually designed in accordance with the Pressure Piping Code, X-rayed, and stress relieved. In most cases they are made of large diameter, heavy-wall pipe. Delivery is unpredictable and may vary from weeks to four months and more, depending upon the size. The suction bottles, depending upon the compressor foundation design, may need to be set in place before the compressor cylinders can be mounted on the engine and the delivery should be followed with much concern.



Scrubber battery.

PUMPS

The following pumps are usually required for compressor station services: Jacket water pumps, cooling tower pumps,



Motor-driven jacket water pumps.

raw water makeup pumps, lube oil transfer pumps, utility pumps, water well pumps, scrubber oil change pump, and miscellaneous sump pumps.

The jacket water pumps are usually the longest in delivery, although cooling tower pump shipments also present a problem. This is due to the fact that the usually specified vertical hollow-shaft totally enclosed fan cooler motors are not as readily available as horizontal type motors.

The water makeup pumps are low capacity, from 100 to 200 gal per min, and may be obtained within a relatively short period of time. Utility pumps usually can be purchased from stock. For water well service, jet type pumps

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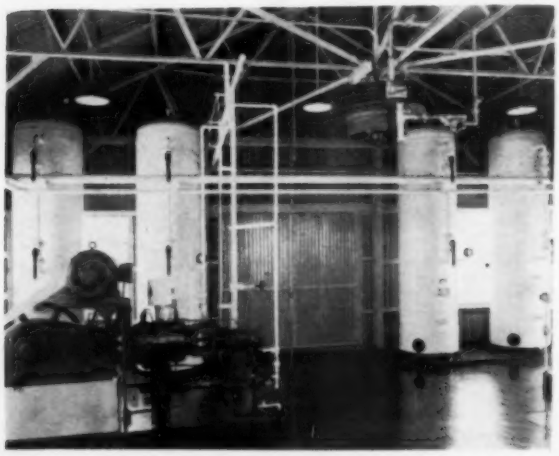
are usually available from stock. This is a point to remember, as the pumps are not usually specified until the wells have been drilled and tested, and by that time water is needed for the job. The problem of supplying water for construction purposes is discussed elsewhere in this article, however.

Pump deliveries verge on the border of "Fair" and "Poor," although considerable tie-up has been encountered on those pumps requiring "explosion-proof" motors. Such pumps, of course, should be ordered as soon as possible. Again, certified prints should be requested, as well as characteristic curves.

In many cases, the purchase of a vertical pump is held up until such time as the setting is determined. This practice, of course, does not lend itself to expediency and the best method to circumvent such tendencies is to place an order for a pump of the approximate setting and make any corrections required on the certified prints submitted for approval. Time is of the essence, and the buyer should remember that though the sales representative accepts on verbal order, the factory does little if anything in preparation of manufacture until the formal purchase order is in its possession. This practice is understandable and it is characteristic of most equipment manufacturers.

STARTING AIR COMPRESSORS

The selection of the starting air compressors varies with the installed compressor horsepower. On main line stations of any magnitude, it has been established that a heavy duty two-stage water cooled compressor of 70 to 100 cu ft per min capacity at 250 psi is most able to supply the heavy demand of compressed air.



Starting air compressor and storage bottles.

One unit is usually motor driven only and it is equipped with automatic start and stop switches and automatic unloading valves. The selection of the drive depends largely upon its location. If the starting air compressor is placed in the compressor building, then an explosion-proof motor will be required, but if it is in an auxiliary building an open type motor may be used. The smaller spare starting air compressor is usually furnished with both motor drive and engine drive. The motor drive is equipped with an automatic start and stop switch; however, the engine drive is equipped with only an automatic cut-off. Often, the spare starting air compressor is purchased with engine drive only. Due to the large starting air requirements separate air storage is installed and the compressors are purchased without an integral air tank. If a compressed air after-cooler is necessary, it should be purchased at this time, complete with separator and dump trap.

ELECTRICAL

As soon as the large electric drive units have been purchased, specifications should be submitted for the purchase of the electrical switchboard, for it is not uncommon to receive it last even though it is among the first of the major pieces of equipment ordered. The time required for delivery of switchboards usually runs from five to seven months, depending upon the type. The buyer should be cognizant of the fact that starter sizes can be altered weeks after the order is released. Cable and conduit should be ordered in the early stages, and lighting fixtures, especially if they are "explosion-proof," also should be bought as soon as possible. Grounding wire should arrive at the job before pouring of the concrete is begun. Other electrical items usually present no special problem.

MISCELLANEOUS ITEMS

The compressor building floor beams or decking, whichever is used, should arrive on the job immediately after the building walls and compressor foundations are poured. Thus, they can be installed and used for the support of temporary flooring while the compressors are skidded on their foundations.

As the order is a substantial one, little time can be lost in placing it. Unless the order is entered with a shop as early as it should be, the cut lengths of the beams may not be available. Most shops, however, will begin accumulating the material as soon as the order is placed. Again, the buyer is advised to base this purchase as an estimate of the actual requirements subject to later revisions. If the steel is pur-

NOTE: Photos are of Pacific Northwest Pipeline Corporation stations, which were engineered by author's company.

The Author

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Lazzari is a graduate of Michigan State College of Mines and Technology with a degree in mechanical engineering. He joined Treco in 1942 and worked on various refinery projects. With Ford, Bacon, and Davis, he assisted in engineering on synthetic rubber facilities. He served two years in the U. S. Navy and was assistant chief engineer for Petroleum Engineering, Inc., before joining the Fish Engineering group.

chased from warehouse and shipped directly to the field. allow for considerable waste.

Miscellaneous structural items have to be given individual consideration and such items as floor plates, grating, pipe supports, trench angle, and handrailing should be ordered from an estimate of the actual requirements. The drafting department cannot supply purchasing with the cut sizes of the floor plate at the time the order should be entered; therefore, an order for the approximate square footage should be placed with the understanding that the plate is to be stored until such time that actual sizes can be given. The buyer is urged to specify cutting tolerances in the order. Pipe supports also can be handled the same way. It is possible to supply a drawing of a typical support and ask various fabricators to quote the price on a pound basis if the stanchions are to be delivered to the job prefabricated. Pipe clamps, guides, and anchors are usually ordered after the design is almost completed. Delivery of these items does not present much of a problem.

The miscellaneous anchor bolts should be ordered well in advance if they are over 1-in. size; 1-in. and smaller anchor bolts usually can be found in stock. The buyer is warned to purchase basement window and door frames, for lack of them may hold up pouring the compressor building basement walls. The pipe sleeves are not needed in the early stages because cut-outs can be left in the walls and the sleeves grouted in later; however, there is no particular reason why they should not be purchased immediately. The sleeves easily could be field fabricated if it were not that the large diameter pipe usually arrives at the job site late.

The delivery of instrument boards presents very little problem. There is no reason to run the risk of a late shipment, however, as they can be placed on order about a month after the purchase of material has begun. Depending upon the location of the job site, it is usually best to ship that board semi-finished so that the finish paint will not be damaged in transit.

In analyzing the quotations for the instrument boards, the cost of crating should be considered, as it is an expensive item and definitely should be provided for if the boards are to be shipped any distance. The station superintendent usually makes arrangements to send the board to a local auto paint shop for finishing.

Walkways and crossovers should be ordered in advance. The drafting department can help delivery by standardizing the design of these items. Thus, an order may be entered for a given quantity of compressor building walkway and shipped prefabricated to the jobsite before the drafting room has the opportunity to include it in a layout drawing.

The sequence of construction is such that usually the compressor mat and blocks are poured first. If such is the case, material such as beam bearing plates, miscellaneous anchor bolts, anchor bolt sleeves, and adequate amount of pipe for compressor air intake is to be sent to the job well in advance. Metal leak strip for sealing concrete joints is required on the job a very short time after the construction is begun, so a takeoff should be made and the material sent out to keep apace of construction.

Trench angle usually is made up in two types—the embedded type, and the bolted type. The bedded type trench angle has to be set in the forms before the concrete is poured and therefore is as critical an item as an anchor bolt. The bolted type trench angle is, as the name implies, fastened to small diameter anchor bolts set in the concrete. Depending upon the availability of material at the jobsite, the buyer is advised to send several hundred feet of angle to the field for miscellaneous purposes.

Items of little monetary value that should be considered critical and are to arrive on the job at the offset are the floor drains, for they, along with a certain amount of pipe, are inserted in the compressor mat.

CONCRETE

The purchasing department should take the initiative in obtaining an estimate of the reinforcing steel requirements. A preliminary takeoff should be made of the forming lumber requirements and submitted to a few of the lumber companies in the vicinity of the job for pricing. If the cost of lumber in the locality appears to be high, then an economic study should be made to determine whether it would be feasible to ship lumber to the job.

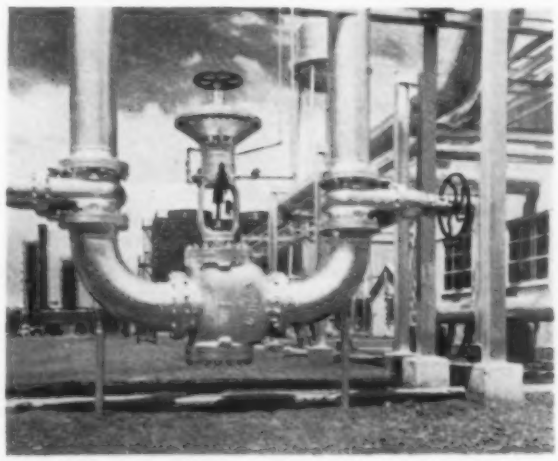
The purchaser should bear in mind that a certain amount of buying should be done by the construction superintendent. A number of "short" items are purchased in the field, and depending upon the scarcity of such items, the superintendent should place himself in a favorable position to obtain them. If a substantial purchase is to be made by the field, the purchasing department should provide the superintendent with the prevailing prices.

The preliminary takeoff also should be made on the cement requirements. If ready-mixed concrete is to be used, a source of supply should be established and a purchase order written on the approximate needs. The order should be written so that disbursements will be made at such time as the ready-mix is delivered and not obligate the company to purchase more than the amount used. In purchasing ready-mix the buyer should consider the company's ability to transport the mix in adequate quantities for large pours. The same type of purchase agreement is to be made for cement. Sand and gravel are usually obtained from the same source of supply as the cement to facilitate transportation problems.

SOIL TESTS; WATER WELLS

Somewhere between the beginning of the station design and the construction phase, soil tests are made as required by the engineering department. Arrangements should be made for the interpretation of soil tests if the contractor does not possess those facilities.

Also at this time, if water is not available from a river or lake, arrangements should be made for drilling the water wells so that water will be available for construction purposes. A well pump should be delivered as soon as possible, in order to benefit by the completion of the wells; however, the drilling contractor's test pump may be contracted for until such time that the water well pumps arrive. If no outside electricity is available, a gear-head should be purchased for temporary installation on one of the water well pumps and arrangements for either purchasing or renting an engine driver should be made. Expediency in this matter cannot be over-emphasized.



Jacket water temperature control valve.

FENCE

Fence material should arrive on the job approximately at the same time that the superintendent does. With the fence erected at the beginning of construction, the duties of a night watchman become minor. A fence will serve to keep outsiders and animals off of the site, thus reducing liability risks.

BOILERS

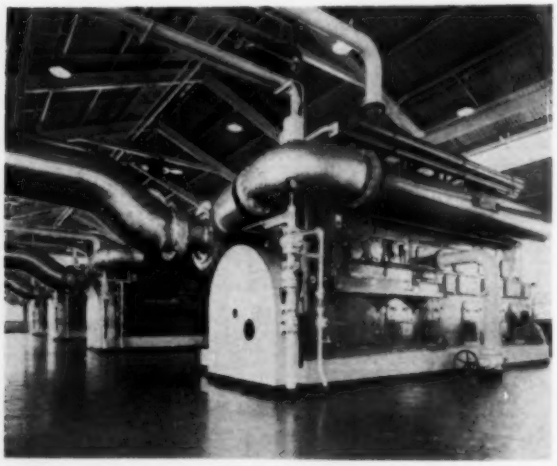
If a heating boiler is required, it should be ordered with the other major items of equipment, although some package units, either of the fire tube or water tube variety, are available with fairly short deliveries. The drafting department will require the physical data for design purposes. Unit heaters, if such are to be used, should be ordered as well as steam traps, convection radiators, vent traps, thermostats, and the like. If unit heaters with "explosion-proof" motors, are required, the purchasing department is to be on the alert for late deliveries.

MACHINE TOOLS

All machine tools required for the compressor station shop have fairly good deliveries with the exception of lathes. Such items as drill press, grinder, power saw, hydraulic press, and miscellaneous shop tools have from immediate to 12 weeks delivery. Lathe delivery may run anywhere between 4 to 12 months. Although a lathe can be set after the station is in operation, it is not a good practice to do so, and it should be ordered as soon as possible.

INSTRUMENTS AND CONTROLS

Reciprocating type compressor stations require relatively little instrumentation, the usual controls being compressor jacket water temperature recording controller, fuel gas flow meter, fuel gas pressure and temperature recorder, and suction and discharge pressure recorder. These instruments can be ordered readily for the only unknown is the



Insulation on compressor piping.

length of capillary lead on the jacket water temperature recorder controller and the fuel gas temperature recorder.

The control valves usually consist of the first cut fuel gas regulators, second cut fuel gas regulators, auxiliary fuel gas pressure regulators, instrument gas reducing regulators, and utility fuel gas regulators for cottages. All these items are purchased with a very little trouble, with the exception of the first and second cut fuel gas regulators. Along with these items, the cooling tower makeup valve and water meter should be purchased. The jacket water temperature control valves for the compressor and auxiliary engines and lube oil temperature control valves also should be considered. All told, instruments and controls have comparatively short deliveries.

A complete gage glass list can be made with little effort. Usually the only vessels requiring high-pressure gage glasses are scrubbers and charge tank. The remaining vessels are provided with tubular gage glasses.

A pressure gage list can be prepared with equal facility. In preparing a list such items should be considered as gas headers, jacket water header at compressor and auxiliary buildings, starting air header at compressor and auxiliary buildings, fuel gas header at compressor and auxiliary buildings, starting air tanks, and scrubber oil charge tank, jacket water pumps, scrubber oil pump, raw water makeup pumps, utility pumps, cooling tower pumps, scrubbers, and instrument gas. Oil pressure gages on the compressor and auxiliary engines are supplied by the vendor as standard equipment. The compressor building instrument board should have the following pressure gages: Gas suction and discharge pressure, starting air pressure, fuel gas pressure, jacket water temperature, and instrument air pressure. The auxiliary building instrument board requires all the above instruments with the exception of the gas suction and discharge pressure gages. The fuel gas pressure, in the case of a four-cycle engine, is usually measured with a manometer.

The usual compressor station requires very few safety relief valves. The only relief valves of any consequence are those on the compressor discharge. Other relief valves are usually installed on such equipment as air compressors, starting air receivers, scrubber oil charging tank, scrubbers, scrubber oil charging pump, first and second cut fuel gas volume bottles, auxiliary fuel gas header, compressor fuel gas header, compressor oil coolers, and utility fuel gas.

Thermowells, if purchased of the stainless steel variety, may have very long deliveries. Lists for their purchase can be drawn up readily. As temperatures of both water and gas in a main line compresor station rarely exceed 220 F, practically all thermometers can be purchased with the same range. Anyone who is acquainted with compressor station operation can take a mechanical flow sheet and make a fairly accurate takeoff. Lack of thermometers will not delay the startup of a station, but lack of thermowells may. Thermometer couplings can be plugged for temporary operation, however, it is a troublesome task, requiring depressurizing of the system, to replace the plugs with thermowells. Thermometers are installed in gas headers, fuel gas headers, jacket water headers, piping to and from all jacket water coolers, gas coolers, and oil coolers, cooling tower risers, jacket water supply to all compressors and auxiliary engines, fuel gas meter runs, and fuel gas heater.

PAINT

The paint need not be ordered immediately. Usually color schemes for compressor stations are not considered until later stages of construction; however, primer should be sent to the job so that structural steel members arriving there may be primed before storing or erecting. The pipe primer, enamel, and wrapping, are not required until piping is begun, which is usually about two to three months after breaking ground. The exception is, as mentioned previously, when a water line has to be installed, then all the material required to lay it should be on hand.

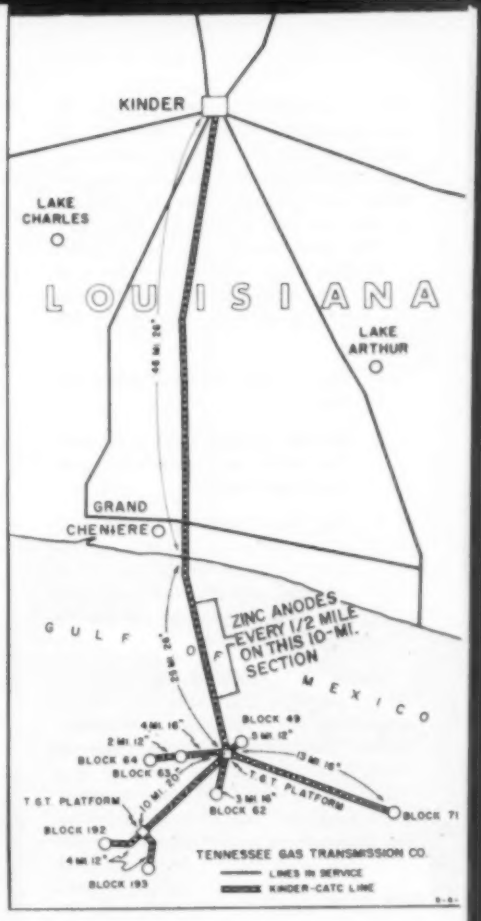
INSULATION

About the only insulation material needed in a compressor station is for burn protection on steam piping. Sometimes the designer may call for insulated exhaust jackets; however, the procurement of insulation presents very little problem and may be ordered during the later stages of design.

Zinc Bracelets Protect Undersea Line

Tennessee Gas is spotting 1000-lb zinc anodes that fit around the pipe like bracelets every half mile on its new offshore Louisiana line. These "bracelets" fit flush with the concrete coating and are designed to protect the line for a minimum of 40 years.

Donald M. Taylor
Gulf Coast Editor



Vicinity map shows the 25 miles of offshore 26-in. pipe of which the center 10 miles will be protected by zinc anodes bracelets clamped onto the pipe.

EVERY now and then engineers in the pipeline industry come up with a better way of doing something, and almost invariably the method or device is *simpler, more efficient,* and *cheaper.* Certainly this was true in the case of the zinc anodes that Tennessee Gas Transmission Company engineers devised for their CATC 26-in. offshore line now being completed in the Gulf of Mexico. These new anodes are made of high purity zinc, cast in 50-lb individual brickettes, which are made up into 1000-lb "bracelets" and fitted around the pipeline at half-mile intervals on the 10-mile center portion of the 25 mile long section of line that runs from the shoreline to a platform at sea.

TGT engineers designed this installation to provide the pipe with protection for 40 years without replacement of the anodes — even if the holidays in the coating total 1 percent of the area of the outside of the pipe.

What are the advantages of these "bracelets?" There are several. Just take a look at the accompanying photos and you will see the most important one. Because the zinc anode assemblies fit flush with the concrete coating, they require no special handling during the construction of the line, and this fact provides a sizable saving in trenching the line. Generally speaking, it is far cheaper to lay an offshore line on the bottom and jet it to grade than to dredge a ditch beforehand and lay the line in it. But in the past, where anodes were used along the run of the line, it has been impossible to jet the pipe down because the high-pressure jets

Semicircular zinc anode bracelets ready to be clamped onto the pipeline. Each half section weighs about 500-lb and contains ten 50-lb zinc blocks.

tear the anode leads from the pipe. To add the anodes later is a difficult and expensive feat. For this reason lines requiring the intermediate protection are either laid in ditches dredged for them or else the line is not covered.

This was the crux of TGT's problem.

To sum it up, the problem that initiated the development of the anodes by the TGT engineering department was this:

1. **The 25-mile line should be backfilled.**
2. **Because of its length good practice called for intermediate corrosion protection.**
3. **But if conventional anodes were added along the length of the line, the ditch would have to be dredged, and the company could not take advantage of the inexpensive jetting.**

Three of TGT's engineers put their heads together and came up with an ingenious solution to the problem. Robert Baldwin of the civil engineering department, Al Stegner and Jack Baxter of the corrosion engineering department reasoned that if the anodes could be clamped on to the pipe like bracelets, flush with the 3⅝-in. coating, the joints of pipe on which the anodes were installed could be handled just like other joints during and after construction. Jetting likely would not damage the anodes, and once the line was down, zinc anodes of proper size and shape would easily last for 40 years.

The more these engineers studied their solution to the problem, the more feasible it seemed. The utter simplicity of the idea dispersed any resistance to it.

How the anodes were made. Their final designs called for 50-lb zinc blocks — measuring 14 in. long, 3½ in. thick with a tapering width of 4 in. next to the pipe and 5 in. at the top. The bottom was concave to fit the contour of the pipe. A ½-in. square steel bar with crosspieces runs completely through each of the blocks near the bottom (or pipe side). These bars were galvanized to insure good contact between the zinc and steel. By welding the bars to semi-circular steel straps, two-part "bracelets" containing a total of 20 individual anodes could be formed to clamp around the pipe. These "bracelets" were made up on a jig of 26-in. pipe.

Assembly method. This anode assembly was fitted over the pipe *after* it had been coated and wrapped. The bottom and sides of the individual zinc blocks were wrapped with polyvinylchloride tape, and the space between the anodes was filled with liquid neoprene, which has a high diaelectric strength and can be applied at ambient temperatures.

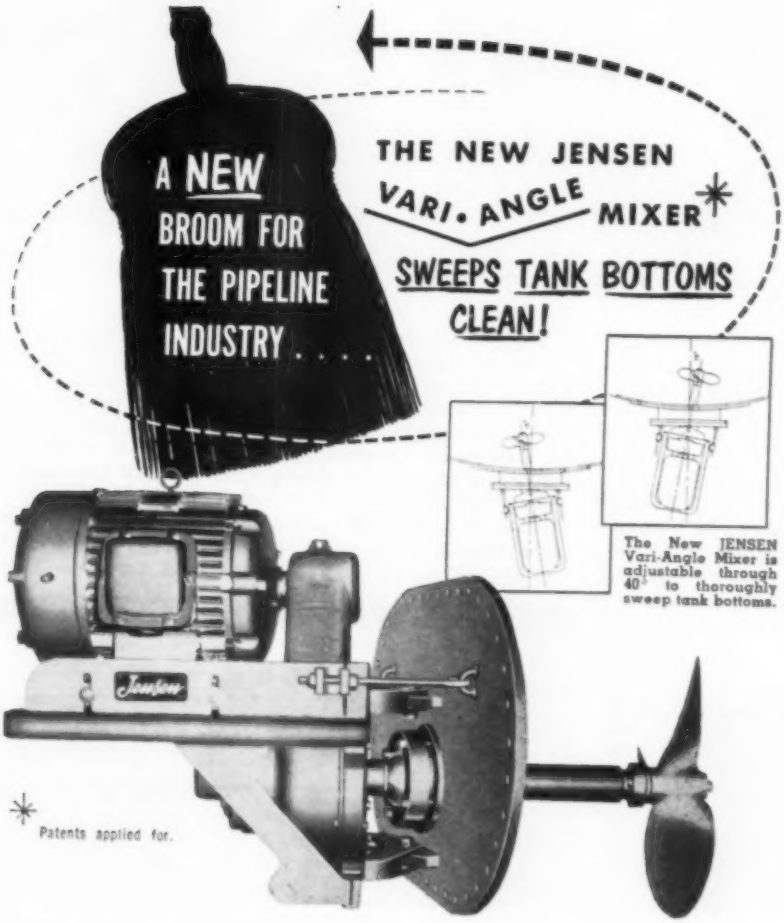
There is no electrical bond between the anodes and the pipe except through the circular steel straps that hold the assembly around the pipe. The latter rings at either end of the zinc anodes are bonded to the pipe with conventional Cadweld connections — four on each ring.

Once the assemblies were bolted around the pipe and bonded to it, pipe dope was lavishly applied over the connections. The joint of pipe was then ready for its concrete coating. In the coating operation the galvanized chicken wire reinforcing was stopped short of the anode assembly. Then concrete was hand-formed around the pipe to bridge the space between the iron ore weight - coating and the anodes. Once the concrete had set, the joint of pipe was ready for transportation to the lay barge.

Why was zinc chosen for this service? Al Stegner, who heads up TGT's corrosion mitigation, explains it this way: First, zinc has a current efficiency of about 90 percent, which means that it is very slow to combine with the salt water and soil. Its life expectancy is more or less directly proportional to the excellence of the coating. For a 40-year life span, each pound of zinc will supply 335 amp-hr. The theoretical pipe-to-soil voltage between zinc and steel measured with a copper sulfate plug is about 1.1 volts.

How to calculate the number of pounds of zinc required. TGT's only concern was the 10-mile center section

Jig for making anode bracelets was 26-in. pipe. The steel bar sticking out of the anodes was welded to the circular ring. The straps beneath the anodes were spaced having identical measurements of the pipe coating over which the anodes will be clamped.



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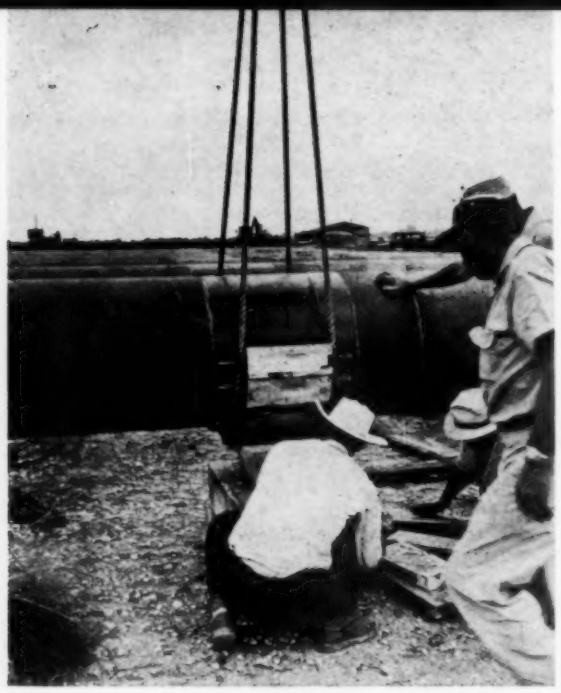
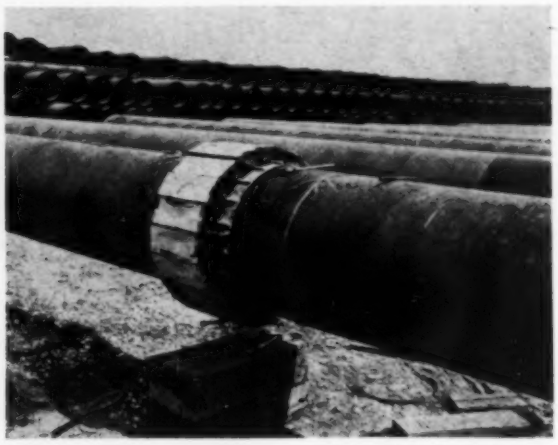


Placing the anode bracelets on the coated pipe. Note the extra wrap of tape over the pipe coating.



Anode is clamped on the pipe ready for electrical bonding to the pipe.

of the line — the several miles on either end can be protected easily by current from the shore, and from the platform at sea. But to protect the center portion from either end it would be necessary to go to rather high voltages. Good practice called for intermediate protection, and the company specified that anodes be spotted along the center portion, as shown on the map.

From the practical standpoint, there will be no sharp line of demarkation limiting the extent of line protected from the ends and that protected from the circular anodes on the pipe. But for calculating purposes, only the center 10-mile portion was considered.

Here is the way the approximate amount of zinc anode material was calculated:

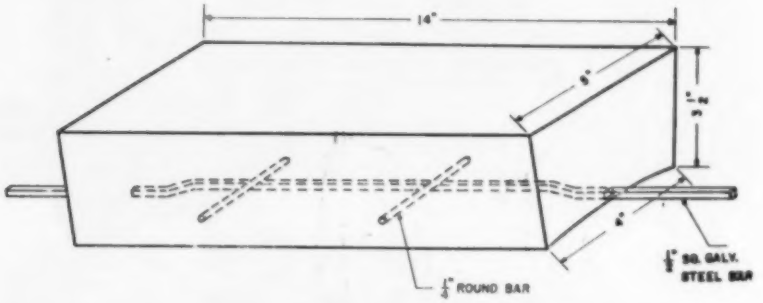
Each anode assembly should protect ½ mile of line for a period of 40 years.

The surface area of ½ mile of 26-in. pipe is about 18,000 sq ft.

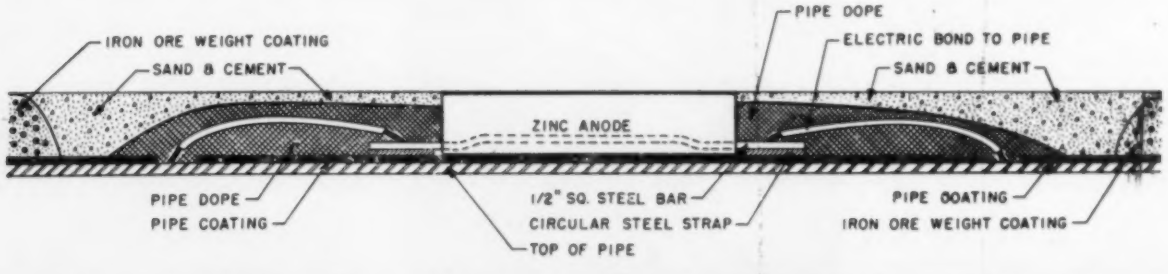
If 1 percent of the pipe area is holidays, 180 sq ft of bare pipe must be protected.

It takes about 5 ma to protect each square foot of bare pipe, or for 180

How the zinc blocks that make up the anode assembly were cast. The ½-in. square steel galvanized bar serves as a connection to the circular ring that holds the anodes in place on the pipe.



Cutaway of top of pipe showing the electrolytic circuit and insulation.



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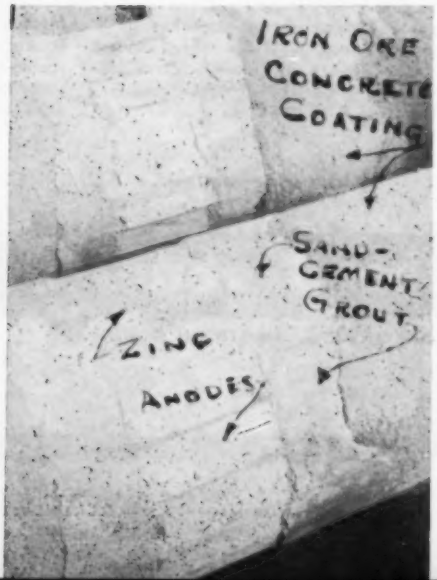
Anode leads and steel rings are covered with pipe dope.

Bonding the anode to the pipe. Each steel circular ring on either side of the anode is electrically connected to the pipe in four places.

After pipe gets weight coat, the gap between the anodes and the iron ore aggregate coating, the gaps are hand filled with cement, sand grout.



Anodes, which fit flush with concrete coating on pipe, are ready for shipment to sea.

sq ft: 180 × 5 = 900 ma or × 0.9 amperes.

There are 350,400 hr in 40 years, so to protect the line for this length of time the current requirements in ampere-hours will be:

350,400 × 0.9 = 315,360 amp-hr.

Each pound of zinc supplies 335 amp-hr.

Number pounds zinc required = 315,360 ÷ 335 = 941 lb.

Other advantages of the circular zinc anodes. It is obvious to anyone familiar with offshore pipelining that there are a number of advantages inherent in these anodes. Here are some of the important ones:

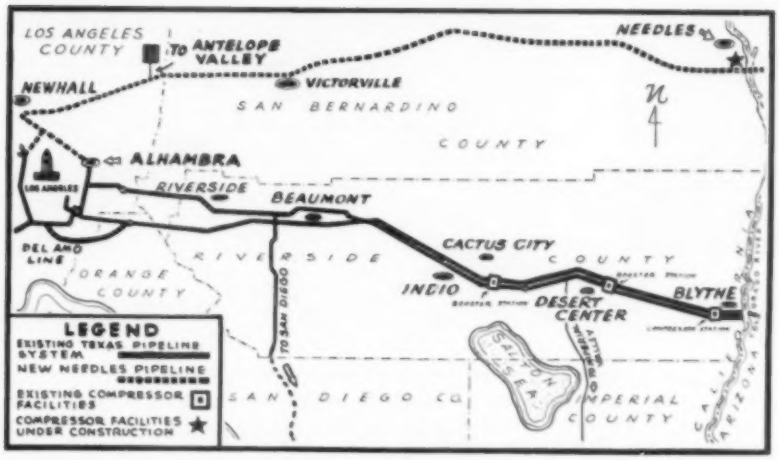
1. **Low maintenance. There are no test leads to be torn off, no buoys to maintain.**
2. **The weight of the joint of pipe containing the anode is just about the same as the rest of the pipe because zinc weighs about the same as the concrete.**
3. **The installations are inexpensive. The cost of zinc runs less than 30 cents per lb.**
4. **The zinc anode assemblies are rugged enough to withstand normal construction practices — the anodes will not crush as they go over the rollers, and they are not in the line of the blast of the jetting machine.**

Conclusion. Simple as this new development is, it represents another step forward in offshore pipelining, which is so important to the development of this country's oil and gas industry.

* * *

Needles–Newhall Line Completed

. . . increasing California's gas imports



Route of the new Needles-Newhall-Alhambra pipeline, shown in relation to existing system of Southern California and Southern Counties gas companies.

Another 200,000,000 cu ft a day is added from Texas, New Mexico, and Arizona by Needles-Newhall line, which crosses the rugged and legendary Mojave Desert.

LOS ANGELES County Sheriff Eugene W. Biscailuz turned a giant valve on August 28 to dedicate a new $33,500,000 interstate natural gas pipeline and released more than 200,000,000 cu ft of gas into Southern California from mid-continent sources.

With opening of the valves, the flood of new gas set a record high of more than 1 billion cu ft of gas coming into Southern California from out-of-state.

The valve was spun open at dedication "valve turning" ceremonies in Newhall, marking initial operation of the new 30-in. Needles pipeline project begun more than a year ago by the Southern California and Southern Counties gas companies.

Sheriff Biscailuz, one-time gas company employee, and F. S. Wade, chairman of the Southern California Gas Company board of directors and member of the Southern Counties Gas Company board, officiated at the ceremonies attended by government officials, civic, industrial and business leaders, and members of the press.

The 285-mile long Needles pipeline is the third complete 30-in. natural gas artery bringing out-of-state gas into the Los Angeles Basin.

F. M. Banks, president and general manager of the Southern California Gas Company, G. W. Wadsworth Jr., president and general manager of the Southern Counties Gas Company, and John Eichelmann, vice president and executive engineer of El Paso Natural Gas Company, the out-of-state supplier for both the local distributing firms, represented the three companies involved in the vital program to bring additional gas supplies to the rapidly mushrooming population in the Southern California area.

The new line was started in the Los Angeles Basin by the two companies during June 1956, when crews from three construction firms began work on the first 49-mile segment between Alhambra and Newhall. This portion of the line was finished and tied into existing systems late last fall.

The major portion of the line—some 241 miles between Needles at the California-Arizona border and Newhall—was started last year with final hydrostatic testing completed on schedule late in August. Overall length of the line is some 285 miles.

Natural gas now being imported into Southern California originates in Texas, Arizona, and New Mexico and represents more than 70 percent of all gas used in this area by the more than 2,000,000 customers of the Southern California and Southern Counties gas companies.

In a second part of the overall project, construction of a multi-million dollar compressor station got underway in May at a site 11 miles south of Needles and about eight miles west of the state line. Approximately one-fourth completed, the new plant is designed to handle the initial increment of 227,600,000 cu ft of gas a day when it is finished in mid-December this year.

At the outset, the compressor plant will house four 2000-hp turbo-charged compressors needed for present requirements. Under expansion planning it is expected that the facility will contain 10 such compressors to meet increasing demands for natural gas.

Exactly 10 years ago, the first natural gas from oil fields in West Texas poured through the original 30-in. Texas Pipeline into California at Blythe, linking this area with out-of-state sources for the first time. Since then, facilities to bring Texas gas to California have been continuously expanded.

Through Rugged, Legendary Country

When pipeliners completed laying

Threading pipe into a suspension bridge, three of which were installed on the system.

Eugene W. Biscailuz, sheriff of Los Angeles County, turns valve to let in the first gas, and F. S. Wade, chairman of the board, Southern California Gas Company, lends a hand.

the 285 miles of 30-in. pipe over the floor of the Mojave Desert, they had succeeded in conquering some of California's most rugged as well as legendary terrain.

In this era of modern-day miracles, transport of natural gas across an expansive desert could seem almost commonplace. Yet the onrushing pipeliners of this century faced many of the same serious weather and geographic obstacles of the still primitive Mojave country that confronted travelers of more than 100 years ago.

During the more than year-long project, pipeline crews traveled the same general path that Padre Francisco Garces cut across the desert sands in 1776. It was this famous Spanish priest-explorer who first traversed the area on his historic crossing of the Colorado River and penetration to the Pacific Ocean.

Along the way, they also followed the footsteps of Jedidiah Smith, the first American to enter California on the overland route. Smith's expedition is history to the West, for it did for California what Lewis and Clark did for the Pacific Northwest. It opened up the great transcontinental routes to California, and covered a wide stretch of uncharted country, laying it open for settlement.

Gas is not the first commodity to cross the rugged fortress of the desert. As early as 1830, three pioneering pack trains carrying supplies to the new West spanned the desert and crossed the towering San Bernardino Mountains. Other trappers soon carved trails across the land and established the famous pack train, "The Spanish Trail." This early highway was used by the Santa Fe-Los Angeles caravans for nearly two decades, until building of the wagon road from Salt Lake City, Utah.

Crossing this historic area, the pipeline crews also passed the "mystic maze," a prehistoric rock formation in the desert near Topock, and Grapevine Canyon — near the Mojave Indian Reservation — with its ancient petroglyphs carved on the walls. And, they saw the ghost town of Calico, once a thriving silver mining town, passed Odessa Canyon and its giant rock formations sprinkled with mine shafts, and could have visited neighboring Mule Canyon where borax was discovered in 1883, giving birth to the first "20 Mule Teams."

Black Mountain and its gem stones were not far off the route of the line near Barstow, situated beyond the wide lava beds covering much of the desert floor. Pisgah Crater and smaller Amboy Crater, both perfect specimens of extinct volcanoes, stand nearby as mute evidence of the Mojave Valley's violent past.

Lowering section of pipe into ditch, which had to be padded because of the rocky nature of the terrain.

Pipe Laying Starts in January

Right-of-way work on the line began at Needles in November, with laying operations beginning at the same location in January, and progressing westward.

One spread, under the direction of Jim McGill, was operated on the line until early May, when work had progressed to a point near Barstow, California, and approximately 130 miles had been layed. At that time, a second spread, headed by Chuck Siewert, began work near Victorville, California, approximately 60 miles from the line's western terminus, and completed the line into the Quigley pressure limiting station, near Newhall. Average peak employment for the two spreads has been approximately 735.

Although an overall average for the first half of the line showed 5000 to 6000 ft of pipe laid daily, some days saw as little as 1000 ft entering the 42-in. ditch. The best day was 16,000 ft.

Prime reason for the periodic slowdowns was the encountering of unexpected rock in some areas that appeared to present easy digging. Work in stretches of presumably sandy terrain often disclosed rock anywhere from 9 to 24 in. below the surface. Althought right-of-way work and ditching were slowed down accordingly, much

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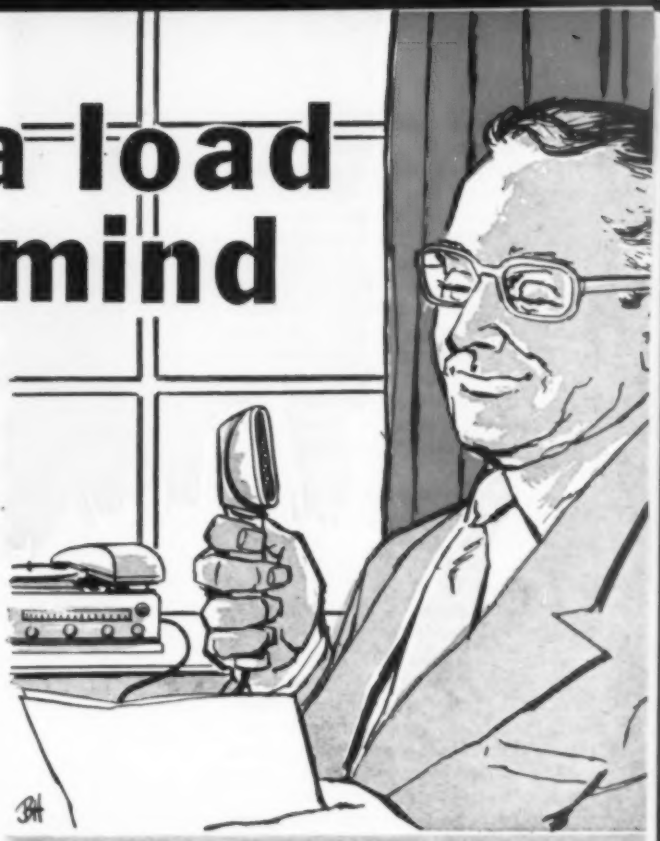

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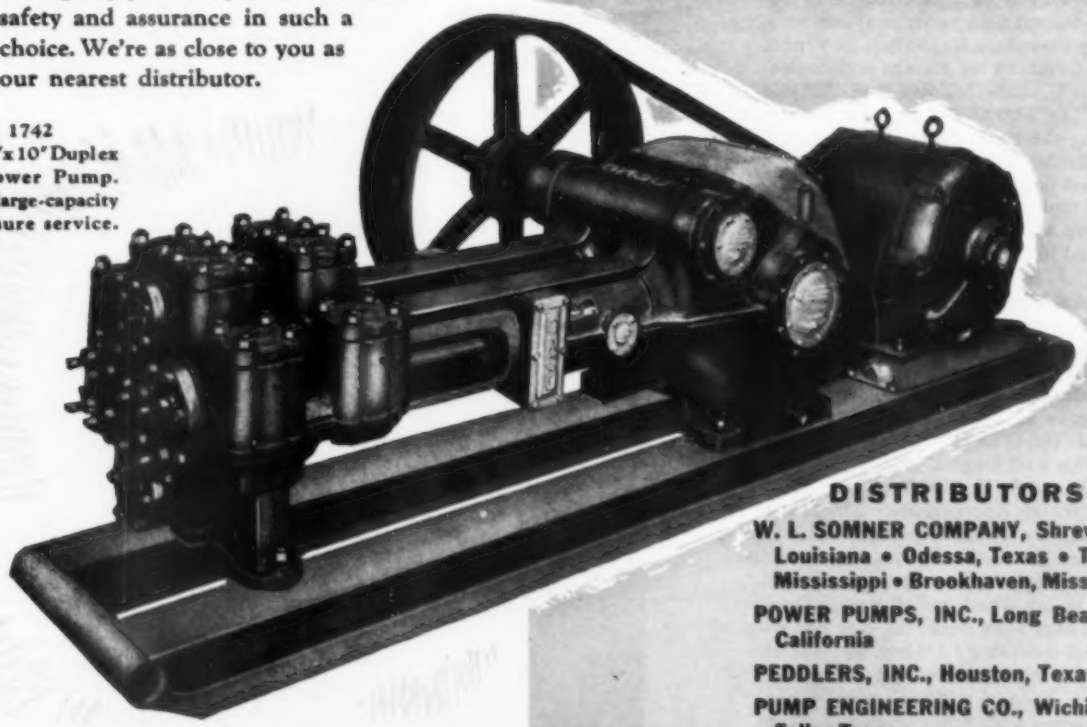

Fig. 1742
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shooting was eliminated by the use of rippers mounted on tractors.

In other areas, where rock was not a problem, the sandy composition of the soil made the maintenance of a firm ditch difficult. On one nine-mile stretch near Ludlow, California, further difficulties were encountered when a stiff wind backfilled the existing ditch necessitating redigging. After the wind refilled the ditch twice, the entire stretch had to be back-filled with a dozer, finish-graded, and completely redug. Because of the soil make-up, most ditching was performed by clamshells and backhoes.

Unseasonably high wind also had adverse effect on the welding and painting operations.

Due to the danger of rock damage to the pipe by standard backfilling methods, the entire 241-mile length of the line was padded.

Double-jointing of the 40-ft lengths of pipe was possible over most of the line, with angular terrain making necessary only about 20 miles of single-joint pipe. The double-jointing yard was moved at approximately 20-mile intervals, and pipe-stringing was carried on by 6 to 10 stringing trucks. When pipe was being initially received, 38 stringing trucks were used to transport it from the railheads at Kelso and Yermo, California, to the storage and double-jointing yards. The best pipe-stringing day saw 32,000 ft of big pipe laid out along the right-of-way. This run was on flat terrain near the pipe yard. The lowest day saw 3500 ft of pipe strung, and took place in a mountainous area where the stringing trucks had to be towed in and out with tractors.

The high percentage of double-jointed pipe used allowed the welding crew to set a good pace in spite of the high winds. Their best day was 16,200 ft. The spread used 250 and 300-amp welders, which were pulled on track wagons by tractors. All welds were made for 1125 psi hydrostatic test.

The 40-ft lengths of 30-in. by ⅜-in. pipe used on the line has a strength of 72,000 psi. Approximately 25,000 ft of 30-in. by ½-in. pipe also was installed in restricted areas near railroads, highways, and populated areas. At points where railroad or highway crossings were made, the pipe was encased in 36-in. by 5/16-in. steel casing.

The 22 main line valves installed were 24-in. by 30-in. plug valves, equipped with motor operators. Blow-off valves were 12-in. by 30-in., with take-off valves on the line varying in size from 6-in. to 20-in.

Although most terrain varied between flat stretches and "foothill-type" mountains, some of the ruggedest conditions were encountered near Barstow. Here, the line runs through Kane

Five weeks of intensive drilling, using percussion drills mounted on cranes, were required to set the initial charge for right-of-way blasting over the Ord Mountains.

Pipelayer cradling the pipe on wrapping and doping operation.

Welding operations were curtailed periodically by high winds. These welding machines are mounted on Athey tracks and pulled by tractors.

Springs Canyon and over the tortuous Ord Mountains. Kane Springs Canyon presented a deep defile with near-perpendicular sides, necessitating the winching of all equipment. By the middle of May, trenching had progressed to the canyon's west wall, where a backhoe was winched up the steep grade by two tractors.

At the Ord Mountain crossing, approximately 15 miles south of Barstow, the right-of-way traversed an almost inaccessible pass composed of solid rock. Five weeks of drilling, using percussion drills mounted on a crane, were needed to set the initial charge.

These two areas were the only parts of the line where right-of-way work had not been completed prior to the arrival of construction crews.

Three Suspension Bridges

Although the right-of-way is almost entirely in the arid climate of the Mojave Desert, three rivers were crossed on its route. Suspension bridges carry the pipe over the Colorado River near Topock, Arizona, the Mojave River north of Victorville, California, and the Santa Clara River near Newhall.

The Colorado River suspension bridge, a 900-ft span, was built and will be operated by El Paso Natural Gas Company, the out-of-state supplier. It is of 34-in. pipe and was designed by Hoffman and Miller, of Phoenix, Arizona, and constructed by Fisher Contracting Company. The two 90-ft towers that support the suspension cables were mounted on 50 ft reinforced concrete piers. Load imposed on the bridge by the pipe and gas is in excess of 78 tons.

The Mojave and Santa Clara River crossings were completed early in June. The bridge crossing the Mojave north of Victorville is 400 ft long, and the Santa Clara span near Newhall is 650 ft in length. Both crossings are suspension bridges.

Contractors

The Needles to Newhall segment was constructed by R. H. Fulton and Company. The Alhambra to Newhall segment, completed last fall, was divided among three contractors: Alex Robertson, Macco Corporation, and Joe E. Young Pipeline Contractors, Inc. The compressor station at Needles was designed by M. A. Nishikian and Company, and is being constructed by Peter Kiewit Sons.

Acknowledgment

Acknowledgment is made to the Southern California and Southern Counties gas companies, and to the News Service of Caterpillar Tractor Company for data and photographs.

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The leathery-faced powder foreman, with 40 years of blasting experience behind him, glanced briefly at the other members of the blasting crew, to see if his humor was appreciated. It was.

The scene was high on the side of an Oregon mountain, where Morrison-Kundsen Company, Inc., one of the world's largest engineering and contracting organizations, is constructing a powder project. The immediate problem was to clear way on the side of the gorge for a flume, through which the waters of the stream now running hundreds of feet below will be diverted by means of a dam.

These men represented years of blasting knowledge gained in mines and quarries, building logging roads to timberlands and damming mountain streams for power projects. In their time they'd worked with every type of blasting material manufactured — so they thought. But now they were witnessing something new. They were going to shatter the solid rock beneath their feet with, of all things, a fertilizer.

They watched intently as a demonstration team poured loose ammonium nitrate fertilizer —in pellet form — directly from the bag into a blast hole. Then they doused the nitrate with diesel fuel oil as it tumbled into the hole. Powder man-helper teams repeated this operation — pouring the fertilizer and fuel oil into the hundred-odd other holes drilled in the area.

The last hole was loaded, and while the powder foreman strung his Primacord from hole to hole, word was passed to clear the area. Deep throated bulldozers, agile "cats" and ponderous power shovels quit their jobs moving tons of rock and dirt about and headed for the safety zone. Workers clambered aboard heavy duty Euclids for the ride back up the winding road to the lip of the gorge. A lone pickup truck made a final check of the work area.

The foreman, crouching beneath a heavy "cat," raised his arm. He would fire in exactly 60 seconds. Watchers held their breath, glanced at their watches and then far down the mountainside, where tiny red flags marked the explosion area.

Someone counted the seconds aloud — "55 . . . 56 . . . 57 . . ." From afar came a faint rumble . . . the little red flags began to tilt . . . the ground on which they stood rose slowly . . . then the rumble became a roar as the earth suddenly erupted. A brief glimpse of a mightly upheaval, then the explosion area was obscured by dust.

A brisk mountain breeze whisked the dust cloud away.

Motors started, men climbed back into trucks. A few minutes later the foreman and his crew were again standing in the work area now a mass of upheaved, shattered rock and gravel.

"All right, I'm convinced," the foreman said. He shook his head in admiration as he surveyed the results of the blast. "Maybe oatmeal won't do it, but fertilizer sure will!"

Thus he joined the fast-growing numbers of powder men and contractors who, in recent months, have been letting ammonium nitrate fertilizer, used as an explosive, help solve some of their problems.

There are three major factors about ammonium nitrate fertilizer which appeal to men doing open air blasting. It's safe to ship and handle, does the

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- Eliminates Fire and Explosion Hazards!
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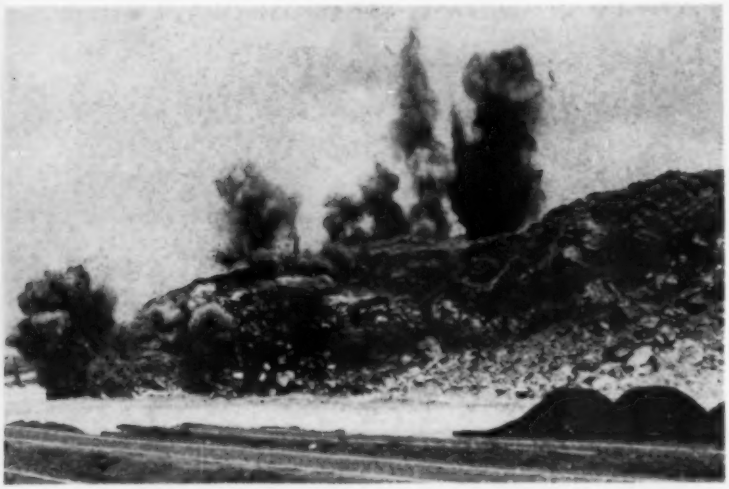
The Flyball Integrator mounts at the point of measurement or on a panel hundreds of feet away. Response and accuracy are completely unaffected by ambient temperature changes or pressure changes in turbine air supply. Ideal solution to all plant fluids accounting and in-process inventory checking. Write for complete details. **The Foxboro Company, 3810 Norfolk St., Foxboro, Mass.**

FIRST IN FLOW

Ammonium nitrate fertilizer gives a lift to construction activities underway in Georgia. It is being used as an explosive to clear land for a modern $15,000,000 electronic push-button retarder yard at Atlanta for the Southern Pacific Railway system.



job just as well and a lot cheaper than conventional blasting materials, and it can be controlled.

Handling the 50-lb bags is easy and safe: The material remains fertilizer until after it is mixed with fuel oil and placed in a blasting hole together with Primacord and a small quantity of dynamite which acts as a detonator. All things being equal, shooting with ammonium nitrate fertilizer averages about a third of the cost of using conventional blasting materials. The percentages have varied in some instances from 25 to 50 percent of former blasting costs.

For an experienced powder man the transition from conventional blasting agents to the fertilizer is pretty simple, since the "powder factor" — the ratio of pounds of blasting agent to cubic yards of earth — is the same. With both nitrate and gelatin dynamite, for example, the "factor" varies from a quarter pound per cubic yard of loose gravel to a pound and a half in hard rock.

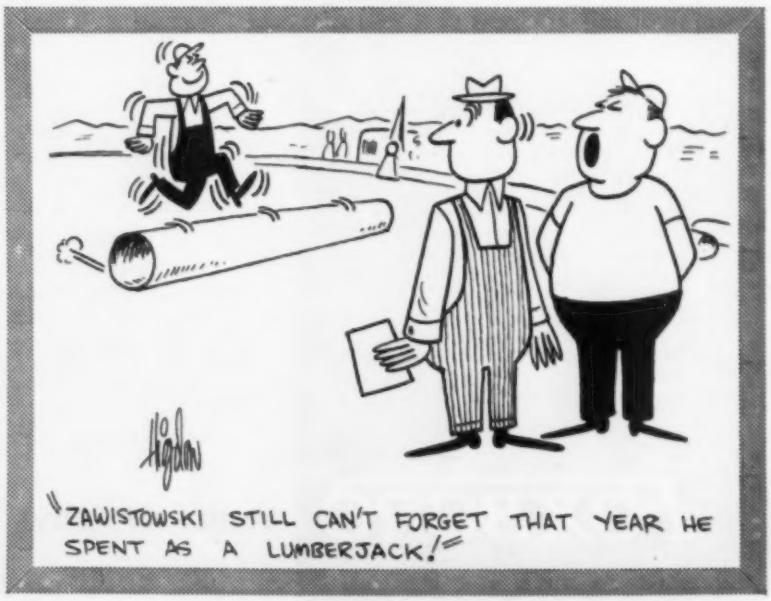
Powder men, with technical advice from Monsanto field men, are finding it a relative cinch to use ammonium nitrate fertilizer as a blasting material in open air jobs. It has been used successfully in 2, 4, 6, 8 and 9-in. holes. Monsanto's field and laboratory tests are providing a continuing flood of technical data.

Already, ammonium nitrate fertilizer has been used successfully by quarries in Pennsylvania, Michigan, and Florida. It has been used in iron ore pits in Minnesota and strip coal mining operations in Ohio and Illinois. The A. E. Burgess Contracting Company has found it does the job economically on an Alabama highway construction project, so have Moss-Thornton Construction Company engineers working on a joint venture with Morrison-Knudsen in building a gigantic railroad yard at Atlanta. Monsanto's Lion Brand Ammonium Nitrate fertilizer is also proving a cost-saver for open pit copper mining operations in New Mexico and Arizona.

Blasting with ammonium nitrate fertilizer has been done overseas as well as in the United States. They're using it in copper mines in Mexico, also in copper and silver mines in Chile and Peru. Recently a shipment went to Basra, Iraq, where a contractor will use it constructing a dam.

It is being used successfully around the world in earth, sandstone, shale, slate, dolomite, limestone, basalt, granite, and taconite.

Acknowledgment is made to *Monsanto Magazine*, of Monsanto Chemical Company, for permission to publish this material. ★ ★ ★



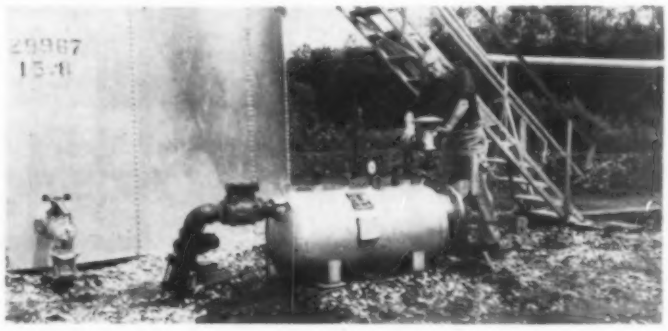
P 615.02

Blow-Case

used to move heavy oil from lease tanks

Saves gager's time and the company money on leases where producer-supplied gas is available

Below, W. A. "Chick" Tillman of Sunset (Louisiana) District opens gas valves on blow-case to start high pour point oil moving from tank at left through the suction line to the field pumping unit. Use of blow-case saves time and money on high pour point oil, due mainly to simplicity of its operation. Above, W. S. Dennis (standing), field gager, and Jesse Wallace, gaging foreman, in the Magnolia (Arkansas) District, are seen using more conventional method of moving high pour point oil, by attaching a portable pump to the suction line. Blow-case might not be feasible in areas where producer-gas is unavailable.



HIGH POUR point oil is a thorn in the gager's side in some areas. It congeals in cold weather — even in hot weather, depending on the crude, when the temperature drops below a certain point.

Producers keep high pour point oil from congealing in their tanks with agitators or heated coils in the tanks. When this oil hits Interstate Pipe Line Company's suction lines to the pumping units, it gets sticky, stubborn, and exasperating. Frequently portable booster pumps must be attached at the lease tanks to get the crude to the pumping units, and starting the oil moving at one lease may take a couple of hours or more.

When gas is available as a by-product of the field, it can be used as a jet to clear the suction lines of old oil before running the new, but this is a time-consuming operation also, often requiring extra steps between tank and pump, and a good deal of determination in clearing the pump gas.

Now, Interstate employee ingenuity has produced a system of moving high pour point oil that is simpler and saves time and money on some leases. It employs a "blow-case," which operates in principle like a pump with gas supplying the pressure directly against the oil. The blow-case operates most economically at locations where gas is supplied by the producer, as in Franklin field of the Sunset (Louisiana) District where the idea has been introduced.

Charlie Hagius, Sunset District mechanic, and George Crain, former district engineer, were working on the idea of a gas injection attachment to kick the oil to the pumping unit when it was discovered that producers were using a similar attachment as a salt-water disposal unit. It was adapted for pipeline use, and now two of the blow-cases are attached at leases in Franklin field.

Hagius and Crain shared $100 as Coin-Your-Ideas winners for the system.

The blow-case is a cylinder about 4 ft long and 2 ft in diameter. It is installed as close as possible to the tank in a battery nearest the field pumping unit. When the tank valve is opened and the heated or agitated oil reaches a certain height in the case, a three-way valve closes the vent exhaust line and opens the gas inlet line which shoots 100-psi of gas pressure into the case to push the oil into the suction line. A check valve prevents the gas from backing into the tank line. As the oil in the blow-case drops from the gas pressure, the gas supply closes off, the gas is vented to the atmosphere some distance away, and the case starts filling up again with oil. This cycle is repeated until the high pour point oil reaches the pumping unit, the time varying with the length of the suction lines.

After turning on the blow-case, the gager goes to the pumping unit and starts it, bleeds it, and then returns to the blow-case and shuts it off. In the case of Franklin field, the operation takes the gager about 30 minutes to put the lease on Interstate's line, whereas it formerly took about two and a half hours using a gas jet system.

"It was a mess getting this oil to move before we installed the blow-case," says Field Gager W. A. "Chick" Tillman. "Sometimes I had to make several trips between the lease and our pumping unit. Now it takes only one round-trip, because this attachment is fool-proof — and safer, too."

On the lease where Tillman was demonstrating the operation, the pumping unit is separated from the lease tanks by a swampy area, and going around it is a good half-mile's distance.

With blow-cases operating successfully on suction lines at two leases in Franklin field, Sunset District is planning to extend the attachment's use by converting three discharge lines to suction lines. Blow-cases would replace three pumps on these lines.

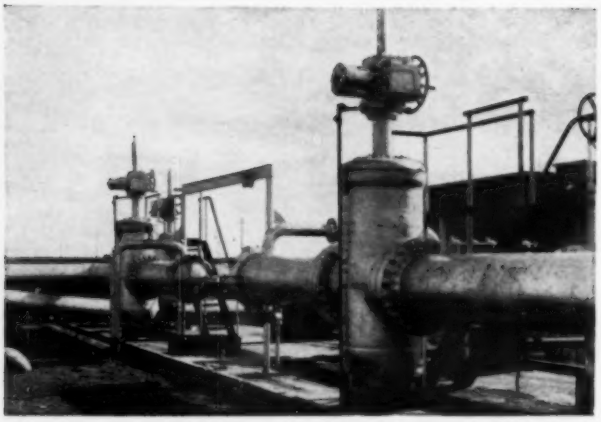
A blow-case installed comes to about $1000, and costs $100 a year for maintenance. A regular booster pump installed is $1600, with $500 required yearly for maintenance. The blow-case uses twice the gas of a conventional booster, but in the case of producer-supplied gas the charge is nominal.

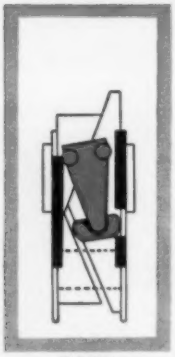
Construction savings also are seen as a result of blow-cases. It's contended that smaller suction lines could be laid on some leases, with the difference being enough to buy a blow-case and fittings.

Acknowledgment

Thanks to *The Liner*, company magazine of Interstate Oil Pipe Line Company, for permission to publish this material.

★ ★ ★





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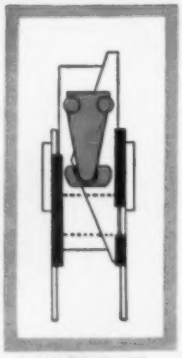
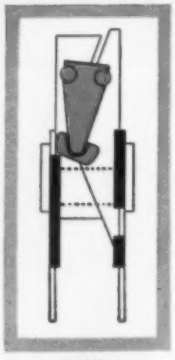
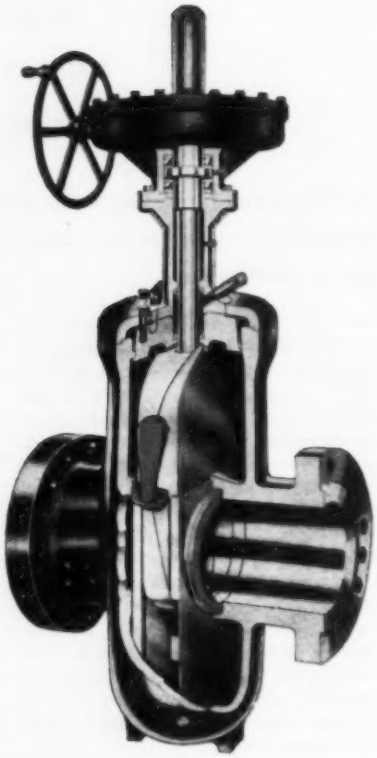


INTERMEDIATE POSITION



OPEN POSITION



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Canadian News Notes

Export gas line. Latest major proposal for an export natural gas pipeline from Alberta to the south has advanced one stage, with the formation of Alberta and Southern Gas Company Ltd., as the operating company that would build and own the big-inch line to run from the Rocky Mountain foothills region fields to San Francisco. Directors of the new Alberta company are representatives of the sponsoring companies: Canadian Western Natural Gas Company, Ltd., and Northwestern Utilities, Ltd., the Alberta gas utility companies; Canadian Bechtel, Ltd., design and engineering of the proposed line; and Pacific Gas and Electric Company, which is the intended purchaser of the gas.

Initial plans call for a line with capacity of about 450,000,000 cu ft a day, but already the sponsors visualize a vastly greater market. Evidence of this is the unusual contract that was signed at the beginning of September, for delivery of future discovered foothills gas from Shell Oil Company leases to A & S. Shell has committed up to 5 trillion cu ft from any reserves that it may discover in southwestern Alberta over the next 10 years. The past record of foothills region gas discoveries indicates that the prospect of this contract being fulfilled is extremely good.

Shell also has committed to the new company an average of 200,000,000 cu ft a day of gas from its existing four foothills fields: Waterton Park (new and just starting development and evaluation drilling), Sarcee (also a recently discovered field), Crossfield, and Homeglen-Rimbey.

The other steps that must be taken successfully before the new project can get into operation are the applications to three governmental authorities: The Alberta Oil and Gas Conservation Board for permission to export the gas; the dominion Board of Transport Commissioners for authorization of the proposed route, and the Federal Power Commission for permission to import the Canadian gas into the United States. The earliest date at which construction could likely start is 1959, even if all applications are successful.

Westspur. Westspur Pipe Line Company gives its August throughput at 56,500 bbl per day. This is an increase of 4013 bbl per day over July, when traffic did not come up to expectations. The June average was 55,372 bbl per day compared to 52,487 bbl per day in July.

The substantial growth factor in Westspur traffic this summer is apparent from the excess of more than 10,000 bbl per day in the August figure over the cumulative average throughput of 46,191 bbl per day in the first seven months of 1957. A deterrent element in the next few months will be the limitation on exports to the United States, due to the schedule set up by the committee on voluntary restrictions under Captain Carson. Westspur had hoped to build up export volume to the Great Northern refinery in St. Paul, Minnesota. The replacement of Alberta crude by Saskatchewan at the Imperial Oil refinery in Sarnia, Ontario, however, appears to be continuing, and this will be an offsetting factor in stimulating further throughput.

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Westspur officials forecast a monthly growth of approximately 3000 bbl per day for the rest of the year.

The 1957 construction program is almost finished. The Glen Ewen terminal facilities are in operation and the terminal building is under construction. All tie-ins on the main line loop are completed. The Midale field is completely electrified, and extensions will be connected to the electric power system as new batteries are installed. The Westspur system at the beginning of August had 384 batteries in operation, including 120 in the Steelman field, 127 in the Alida and Nottingham fields, and 63 in the Midale field.

Kenora River Crossing. Progress is painfully slow on the major bottleneck that will delay completion of the Northern Ontario Crown Pipe Line Corporation 30-in. natural gas pipeline between the Manitoba-Ontario border and Port Arthur on Lake Superior. This is the 6000-ft triple crossing of the Winnipeg River a mile downstream from Kenora, under contract to Canadian River Construction, Ltd. Three channels have to be crossed, with two islands between consisting of solid rock crags up to 100 ft above water level. The approach on the east side rises to almost 300 ft and on the west side to about 200 ft. Vernon Gayheart is general superintendent, Blackie Tubbs, rock foreman.

The contractor is using two twin-drill units hung from sidebooms of Cat 583 pipelayers, and a small Gardner-Denver "Arrowtrack" drill mounted on its own tracks, winched by a Cat 583, to drill the right-of-way and ditch on the land portions. For the river bed a 14-ft ditch is being drilled by three double churn drill units on welded steel pontoon barges, anchored with ¾-in. steel cables to both sides of the channels. Shot holes are cased for loading, then the 6-in. casing is pulled before they are blasted. C.I.L. 75 percent forcite is being used for blasting. Shot rock is dug out of the channel by a dragline.

The total ditch distance under water is approximately 1260 ft. The channels are fairly level, with solid granite rock base. One channel contains some sand stringers over the rock. The current flows at about 12 to 15 mph and elevation of the water varies considerably through each week because of the variations in operation of a large pulp mill at the point where Lake of the Woods empties into the river.

Objective ditch completion date is December 1, but it is not expected that this can be met unless an exceptionally open fall season occurs. Snow normally starts in this region in October and can be several feet deep before the end of November. ★ ★ ★

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Don't Miss the 1957 Construction Round-Up

listing those lines that are under construction, planned or proposed.

Beginning on page D-21 in this issue

IN PIPELINE MICROWAVE
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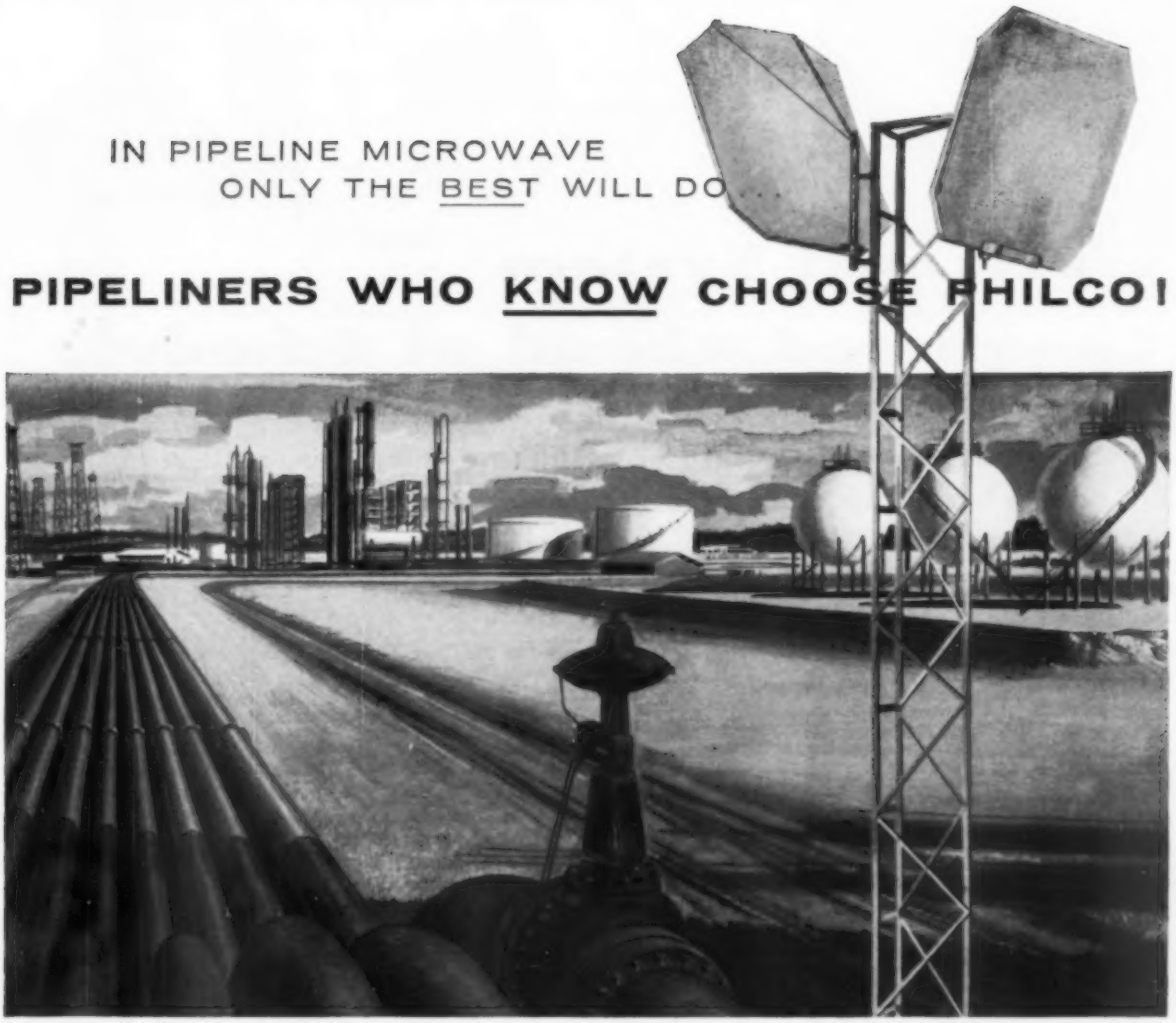

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P 623.

Leslie Orr Rowland

Westcoast System Completed Ahead of Schedule

Not quite two years required to construct 649-mile, 30-in. gas line from Peace River area, Canada, to Sumas, Washington, over the Canadian Rockies

Pipe gang on section two in mountainous region where steep grades were the order of the day.

THE SECOND conquest of the Canadian Rocky Mountains by pipeline, launched in the late fall of 1955, was completed two months ahead of schedule by Westcoast Transmission Company, Ltd., with its 649 miles of 30-in. natural gas pipeline. The system extends from the Peace River block gas fields to the United States border at Sumas, Washington, a short distance east of Vancouver in British Columbia.

Final tie-in weld on the last section to be completed was made near the northern end of the line on August 10, and the entire line was tested by the third week in August. The original scheduled completion date had been November 1, 1957, not quite two years from the start of construction.

System began delivering gas under firm contracts September 1, with a build-up expected quickly to the initial volume of 300,000,000 cu ft per day. Even before completion plans were underway for an early increase of rated throughput from the initial 400,000,000 cu ft per day to 650,000,000 cu ft per day.

Work on the first four down-the-line compressor stations and on the input station was well advanced at the end of August, with all jobs proceeding on or ahead of schedule. The large gas processing and sulfur recovery plant near the point of origin of the line was also going ahead on schedule, with the more urgently needed units being pushed ahead.

Designed and engineered by Canadian Bechtel, Ltd., for the owner, the Westcoast line traverses some country that has never been touched by pipeline before. It is the first major natural gas trunk line to be built in western Canada and provides a transportation outlet for one of the largest gas reserves in Canada, the Fort St. John and adjacent fields in northeastern British Columbia and northwestern Alberta.

Market area served includes the entire interior of British Columbia, with a population of more than 100,000 accessible to gas service, and the almost insatiable Pacific Northwest region in which the El Paso system has contracted to take the major portion of the gas to be moved through the Westcoast line.

The 1957 program actually was considerably less than half of the total line construction, although it included a large part of the auxiliary facilities. Because of the early start in the lower Fraser Valley in November 1955, immediately after construction was authorized by the various governmental authorities, and because of extensive winter work on pipe stringing and double jointing as well as clearing and grading right-of-way, the 1956 construction season saw approximately 434 miles of pipe in the ground, leaving only about 225 miles for the 1957 season.

The outstanding accomplishment of 1956 was the completion of all pipelaying on section one, the first 120 miles from the point of origin at Taylor, British Columbia, a short distance south of Fort St. John on the Alaska Highway. This job was contracted to Dutton-Williams Brothers, Ltd., under spread superintendent Orville (Red) Graves, who was succeeded about halfway through the job by Thelmer E. Davis. This section, which crossed the main continental divide in the mountains, was kicked off at the beginning

Compressor Station at Clarksdale, Miss. and Dispatching and Dehydration Station at Eunice, La., which are among those interconnected by RCA Microwave System

Texas Gas Transmission Corp. Installing 32-Channel RCA Microwave System

RCA Microwave Network Provides 32 Voice Channels Expandable to 60 Channels in 700-Mile System

Texas Gas is currently installing an RCA CW-20A Microwave communication system. The initial 32 channels will include dispatching and operational party lines, private lines to each compressor station, and a mobile radio control circuit to connect 118 mobile radio units.

Twenty-three compressor stations, plus field offices in Kentucky, Tennessee, Mississippi, Arkansas and Louisiana, will be provided with dependable integrated communications facilities.

The new microwave network will tie switchboard facilities at Guthrie and Owensboro to all other system points and provide instantaneous service between any two locations. Installation is on a turnkey basis by RCA which is also training Texas Gas personnel in operation and maintenance.

Further particulars on the use of dependable RCA Microwave in utilities, pipelines, offshore drilling, turnpike and other applications will be mailed on request. RCA Microwave specialists are experience-qualified to answer your questions and help plan your installation

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Crew lines up joint of pipe for the stringer bead.

of May and was welded out in November with snow on the ground and below-freezing temperatures for the last two months.

Ditching on this section included about 35 miles of rock, comprising the entire east slope of Pine Pass and part of the descent down the west slope to Azouzetta Lake where the section ended. Extremely heavy timber was found in this area and there were frequent stretches of swamp and muskeg, between the rock outcrops, involving mud problems in wet weather. The portion over the summit of the pass was solid rock for several miles, with typically steep mountain grades, including combinations of hills and side grades. As the season was unusually wet, mud was a constant obstacle and the maximum footage was about 7000 ft per day, with an average of about one mile per day for the entire job.

Most of the ditching was done by nine backhoes. Three rotary ditchers were used wherever it was practical to run them in for short distances, and they were winched in to some well-filled places between rock outcrops for as little as 200 or 300 yards of ditch.

Rock ditch was drilled with jackhammers and twin wagon drills, the latter mounted on tractor sidebooms. In many places the right-of-way had to be drilled and shot to a depth of 10 ft in order to level it enough for ditching and movement of vehicles. This was done with a jackhammer crew as much as possible, followed by drills when necessary.

An unusual feature of the spread was its complete self-sufficiency in accommodation, with a huge trailer camp comprising 89 units that could house up to the maximum number of 600 men who were employed on the spread at the peak of activity. Catering was handled under subcontract by a Vancouver firm that specializes in camp catering.

Heavy Rains On Section Two

The larger second section, made up of 210 miles running almost straight south from Azouzetta Lake to Milepost 329.4 a short distance south of Alexandria and the No. 5 compressor station at Australian, was awarded to Canadian Bechtel, Ltd., which laid 145 miles in the 1956 construction season, leaving 65 miles for 1957.

The Bechtel spread, under superintendent Mike Finnerty, encountered a large amount of rain in the early part of the 1956 season and throughout 1957. This complicated a difficult ground condition consisting of many sections of bog and swamp that are heavily wooded and hold water in the ground.

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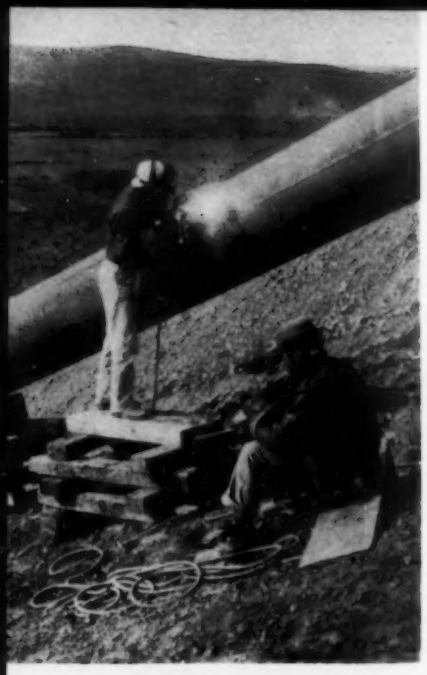


This steep slope is the north wall of Peace River Valley.

The spread worked from the south end of the section, finishing up on the south slope of Pine Pass, and drilling and shooting through a total of 15 to 18 miles of discontinuous but tough rock in the last 35 miles.

Grades were particularly steep in this region, which is pure mountain terrain, and in many places there was almost a straight drop of 1000 ft or more from the right-of-way grade to the highway below. Access shoo-flies were cut as much as possible, using switch-backs to reach the right-of-way, but the average frequency through the heavy rock area was about every three miles. This portion also was heavily wooded.

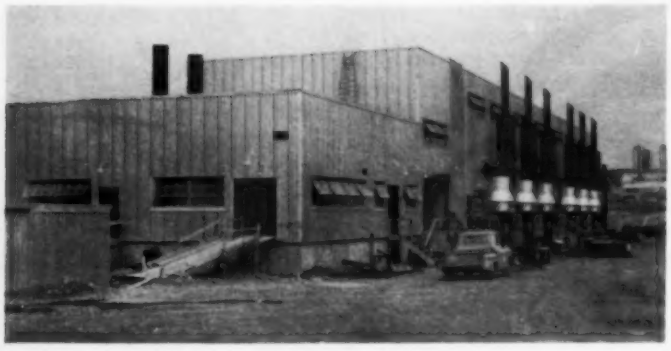
The first 100 miles from the south end were along the Fraser Valley and across the numerous tributary creeks that intersected the right-of-way, some of which presented steep grades up to 30 percent and made anchoring of tractors necessary for lowering in. This portion also had the heaviest timber and the thickest soil, and nine heavy bulldozers were used by the right-of-way gang for clearing and grading after the primary work of the subcontracted brushing to take off the heavy timber. The next 80 miles were along the valley of the Crooked River, which parallels the continental divide and which the right-of-way leaves for the last 30 miles to turn almost at right angles for the climb up the steepest part of the pass.

A mobile trailer camp was established for the 1957 season at this point, where the line also crosses the Parsnip River, which runs parallel to the Crooked River for several miles and joins it a short distance to the northwest.

The ditch work was kicked off on May 10 for the 1957 season, with considerable snow still on the ground. Bulldozers were used to clear snow ahead of the rock gang, which worked independently of the ditchers and backhoes. Drilling was done with four sets of twin drills mounted on sidebooms of heavy tractors and powered by 600-hp air compressors. An average of 350 to 400 ft of ditch per day was drilled with each set and the rock ditch was completed just barely ahead of the pipe gang, early in August.

Shot holes were drilled with tungsten carbide bits, averaging 8 ft of depth to ensure the minimum 6 ft ditch specified in the solid granite rock. Holes were drilled on 30-in. centers and 40-percent gelatin was used to give complete breakup of the granite so that it could be handled easily by backhoes to clean out the ditch. The average life of bits was 1000 to 1500 ft. Holes were staggered across the ditch width.

Stringing, which was done under subcontract by Canadian Parkhill Pipe Stringing, Ltd., was handled with conventional stringing trucks on the southern portion of the section and as far as practical on the northern rock portion. Transfer to Athey wagons was avoided for the most part by towing the trucks with one or two small tractors up the steep access trails and along the right-of-way in this area.



Initial compressor station near Taylor, B. C., in late stages of construction.

Final tie-in being made on Alberta line of gathering system, just south of Taylor.

Through Wild Country

Pipelaying in the 1957 season was facilitated to some extent by the wild character of the region, with only one rail and one road crossing in the entire 65 miles. This compensated a bit for the supply problems imposed by the same factors.

There were two canyon spans that were too steep to bury the pipe, one 80 ft across the Ralston Creek and the other 40 ft across the Bijou Creek. All other pipelaying was done conventionally.

All equipment except welding ma-

chines on the firing line was mounted on trucks, which had proved a time-saving method in 1956 and was extremely valuable in the exceptionally wet summer of 1957 when some rain occurred almost every day. The weather was the principal factor in slowing down progress so much that, in spite of the early start, the final tie-in weld was not made until August 15.

An average footage of one mile per day was accomplished on pipelaying and wrapping, and 9000 ft was the best day on the pipe gang. Steep grades throughout the job required considerable winching of tractors and welding machines, and the welding machines all had to be anchored on slopes. Frequent cataracts crossed the right-of-way, due to heavy runoff from rainfall, and these created patches of mud that made heavy going for the pipe gang and dope gang tractors. The pipe gang, however, got by with relatively light equipment, using an MD7 sideboom tractor for line-ups, a D7 towing the three track-mounted stringer bead machines, and a D6 towing the four track-mounted hot pass machines. Only two welders were employed for the stringer bead, and eight worked on the firing line. A feature of the spread was the exclusive employment of Canadian welders on all gages, including tie-ins and utility. The hot pass unit was split into halves on two separate Athey wagons, for greater mobility, but both were hauled by the one tractor.

Ditching was done approximately 50 percent by the two big ditchers that worked on the spread in 1956, and 50 percent by nine backhoes, all of which were purchased new this season in Canada. The backhoes worked along with the ditchers as much as possible, and with the drills, and ditch was cut ahead of the pipe all the way because of the limited working space for backhoes on the right-of-way after pipe was strung.

The heavy equipment on dope gang and tie-ins, which featured the 1956 construction, was on the spread again this season. The dope gang used four 583 pipelayers, and the tie-in gang had three. Tie-ins were spaced about a mile apart on an average, as the rolling terrain permitted, but few slack loops were needed because the frequent hills, involving sags and overbends, and the sidebends for curves required by the mountainous topography, provided plenty of slack most of the time.

The contrast in the two seasons and the moderate contrast in the terrain between 1956 and 1957 was exemplified in the top footage of 12,600 ft of pipe welded on the best day in 1956, in September, in contrast to the 25 percent less laid on the best day in the current season.

The "desert" section, number three, also occupied a large mileage of 209 miles, starting at Glenwalker, 10 miles southwest of Merritt, just above the Coquihalla Canyon in the southern British Columbia mountains, and terminating at the point where section two started near Alexandria. This section was under contract to Conyes Construction Corporation, with Harlan Evans as spread superintendent.

Stringers Have Problem

This section included the parts of the right-of-way that are fartherest from good roads and involved the most difficult problems of access for stringing trucks. In both the 1956 and the 1957 seasons, in several areas, stringing trucks had to use old logging trails, being winched up by tow-tractors on the steepest grades, and a time schedule had to be maintained for ingoing and outcoming because trucks could not meet on the narrow trails. In some areas it was possible to arrange for the trucks to use alternate trails for travel in opposite directions, leaving the right-of-way by a different trail on the return trip.

The first 55 miles were across the interior desert plateau, parallel to a very primitive and rough campers' trail past several small wilderness lakes, contain-

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ing many steep grades where bending had to be done on 80 percent of all joints. Pipe for this area was all strung as single joints. The next 15 miles were up the almost inaccessible Deadman River Canyon from Savona (the main interior takeoff point for the Inland Natural Gas Company, Ltd., distribution pipeline system). Then followed a stretch of 55 miles across country through heavily wooded terrain with no access roads, to a point where the line intersected the main Cariboo highway, which it followed for the next 84 miles to the end of the section.

The Conyes spread, favored by comparatively dry weather in the desert terrain, got 122 miles laid in 1956 and had only 87 miles to go this season. The 1957 construction, slowed materially by the wet weather in the off-desert region, averaged only a mile per day, although the pipe gang laid 250 joints for a total of 10,000 ft on its best day. The country for the whole section is almost continuously rolling, with alternate hills and swamps, so that bends of all types fairly well did away with slack loops, and tie-ins were spaced far apart because of the few roads and rail crossings and the uninhabited nature of most of the territory.

As was the case with the other spreads, the ditch was carried far ahead of the pipe, except for the last eight miles where there was some danger of caving. The job was welded out on July 20 and doped out the following day, with final tie-in welding completed before the end of July. Station tie-ins at the site of the No. 5 compressor station were made during the first half of August.

This spread had the distinction of being the only one in western Canada to have two double twin-arc welding units on its pipe gang.

One of the principal ditching hazards on the entire section was the frequent occurrence of stray boulders, often of large dimensions, in the old glacial river channels that traverse the British Columbia interior. The boulders are found in largest concentrations at the hilltops, where the glacial streams deposited them because they were too heavy to wash down to the lower levels. By using hand shoveling to dig the boulders out of the ditcher wheel frame, and by permitting the buckets to pick up the smaller ones, it was possible to cut a large proportion of ditch with the two rotary ditchers. On steep slopes the ditchers were winched with tow-tractors both up and down.

Difficult Grades and Poor Access

The most diversified section, and the one that involved the most difficult grades and access, was section four, contracted to Universal Pipe Lines, Ltd., a subsidiary of Mannix, Ltd., with Vic Williams as spread superintendent.

This section began at Sumas, on the international border 50 miles east of Vancouver, and traversed the great swamp of Sumas Prairie, which is 15 ft subsea in elevation for 15 miles in length. Then it followed the lower Fraser Valley for 36 miles to Hope, crossing innumerable fences in this highly congested and heavily populated market garden and dairy farm region. At Hope it turned east, away from the northward canyon section of the Fraser, to plunge into the Coquihalla Canyon, already occupied by the Trans Mountain Oil Pipe Line, and containing some extremely steep grades. It followed this for 20 miles, then left it to cut across 20 miles of the Boston Bar Creek Canyon to the head of the Coquihalla River, and turned up the Coldstream River Canyon for the last 20 miles to the terminus at Glenwalker. This spread also started at the downstream end of its section and worked up the line to the point of origin.

Because of the moderate winter climate in the lower Fraser Valley, the spread began work here in November 1955 with the laying of pipe across what veteran pipeliners said would have been easier going if it had been an open lake. The entire Sumas Prairie

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Welders winching one tow-tractor with another to get welding machine up a hill. Skids are used for wheel blocks.

portion had to be wellpointed to draw the water out of the ditch long enough to get the pipe lowered in. Ditch caving occurred to a width of about 10 or 12 ft, because the water table was literally on the surface.

The 1956 construction program carried the work to the beginning of the canyon areas, and included the very difficult crossing of Agassiz Mountain at Hope, where the only access was by barge across the Fraser River, which had to be crossed every day by the entire crew. The 2800-ft descent of Angel Mountain in this area had a pitch of 52 deg.

A winter start on rock ditch in the canyons paid off handsomely in rushing the job of pipelaying for the 1957 construction season to a completion date of July 12 for the final tie-in weld. Jackhammers and twin drills, the latter mounted on tractor sidebooms, were used for the rock ditch. The techniques were about the same as used on the other rock ditch gangs, except that the rock work was more extensive because of the steepness and frequency of the slopes.

So inaccessible was the Boston Bar Creek Canyon, and so steep were the grades, that it was decided to yard-coat all pipe for this 20-mile stretch, to lighten the load of dope gang equipment on the right-of-way and to avoid possible accidents from tipping or spilling of dope pots.

To speed completion of the job, a poor-boy subsidiary spread was put to work at the north end of the section and worked south to meet the main spread. The result of this organization was to push completion date ahead to July 12 for the final tie-in weld, several weeks ahead of the completion date for section two and a week ahead of completion on section three.

Eight Major River Crossings

Eight major river crossings were involved in the whole job. Two were submerged, five were carried overhead on bridges built specially for the pipeline, and one was hung on an existing highway bridge. A total of 310 highway and railroad crossings were made, mostly in the lower Fraser Valley congested area, and innumerable minor crossings of small creeks and streams and secondary roads were put in. Most of the river crossing work was completed by the end of the 1956 construction season, including the two submerged crossings, the Parsnip River on section two and the Coquihalla River on section four.

Suspension bridge crossings were built in 1957, starting in the winter, over the Fraser River for a distance of 1300 ft at Prince George, and over the Quesnel River for 1200 ft at Quesnel. They were contracted to Barker Construction Company, Ltd. A third suspension bridge was installed over the Thompson River near compressor station No. 7 at Savona, and work here

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was completed the middle of August. The fourth bridge was built this summer to carry the line across the Fraser River in its lower canyon portion just south of Hope where it enters the farmland valley. This bridge, with a clear span of 1470 ft, was constructed by Pipeline-Bridge-Foundation Company, which also built the fifth river crossing, completed on July 15, the long suspension bridge span of the Peace River at Taylor, a distance of 1675 ft.

The component companies in the joint ventures were Marine Pipeline & Dredging, Ltd., Marwell Construction Company, Ltd., British Columbia Bridge & Dredging Company, Ltd., and Iroquois Constructors, Ltd. The utilization of the highway bridge is at Agassiz, where the line crosses again from the north side of the Fraser to the south side for its final run to Sumas.

Extensive Gathering System

The enormous field gathering system designed to pick up gas from the many supplying fields in both Alberta and British Columbia was an even larger job, in terms of total mileage, than the main line work for 1957. A small start was made on the gathering lines in the fall of 1956, with laying of eight miles of 18-in. in the Fort St. John field. Fifty miles of grading were finished before snow halted the work.

The gathering system was designed in two main sections, to accommodate the two completely separated sources of supply in Alberta and British Columbia. The Alberta fields are supplying dry pipeline specification gas, whereas the British Columbia fields supply gas containing a fairly high percentage of hydrogen sulfide.

The Alberta fields have been connected to the initial compressor station by a 45-mile, 26-in. main gathering line, starting at the Pouce Coupe South and Gordondale field laterals and ending at the main compressor station at Taylor, British Columbia. Another main 26-in. line extends from the main station northwest along the Alaska Highway for a distance of 41 miles and a 20-in. line from that point to the West Buick Creek field gate, a distance of 18 miles.

British Columbia gas is brought into a gas processing plant at Taylor, on the same site as the compressor station, and is delivered as dry specification gas to the station after processing. Alberta gas comes into the compressor station site across an aerial suspension bridge over the Peace River, and over the same bridge, flowing in the opposite direction, goes the mingled stream of gas from the compressor station down the main Westcoast line toward Vancouver. Outgoing gas is carried in the 30-in. pipe, which continues on down the line.

The bridge spans a distance of 1675 ft between towers and is one of the longest suspension bridges in Canada. Construction was completed in the late summer of 1957 after a construction period of a little more than a year.

Gathering system construction for 1957 was let as a single contract to Canadian River Construction, Ltd. E. L. "Tex" Maggard was spread superintendent. A single spread was used for both main gathering lines and laterals, with the necessary laterals being laid as side jobs in the order in which they came up in the course of construction. The spread kicked off at the Alberta fields in the early spring of 1957 and finished at the West Buick Creek end the last week of August.

By using the full spread on the laterals, tremendous footage was possible, which more than made up in time saving what was over-rated in equipment. The entire 12-in. lateral to the southeast Fort St. John field, for example, was laid in one day, a distance of 21,200 ft.

Terrain is about half rolling farm land and half bush, with some areas of heavy swamp and mostly hilly ground. At one point seven miles of riprap were laid down across a muskeg. Ditching was done mostly with two rotaries.

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running on a single and a double shift basis for a total of 36 hours per day and making an average of 10,000 ft. The greatest topographical problem was the valley of the Peace River, which presented an 80 percent grade up the lower part of the hill on the north side and a similar grade in two different places on the south side. On the crossing of the Kiskatinaw River, south of the Peace River crossing, occurred the most difficult combination curve and bend on the whole job. This was a 26-deg sidebend on a hill and required five tractors to hold the welded pipe section steady for doping.

Average bending occurred about once in three joints but the areas of bending were concentrated and some overbends and sags on small creek crossings or hills ran to 40 deg. One extreme sidebend for a road crossing was 119 deg.

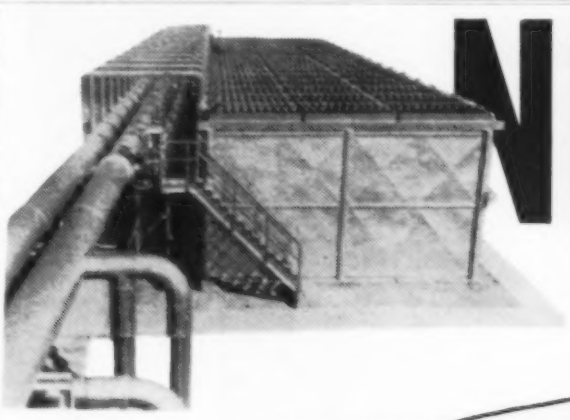
An unusual feature of the pipe gang, considering the fairly rough terrain, was the mounting of welding machines on rubber tired wagons for the third machine on the stringer bead unit and the double twin-arc unit on the hot pass. The hot pass units were split, with two conventional machines on a wagon for the second unit. The two lead stringer bead machines were mounted on a tractor. Average footage on the 26-in. pipe was 10,000 ft, although there was not much chance of getting a straight run for as much as a mile.

Average footage for both the pipe and the dope gang on the various 12-in. laterals was more than 15,000 ft, with top days of 17,000 to 18,000 ft on the dope. Slack loops were left at intervals of about one quarter of a mile under average conditions of temperature, sun, and topography. Because of the infrequent roads in the area, and the complete absence of rail crossings, tie-ins were reduced to an average of about one to the mile, but the tie-in gang had ample equipment, including two D8 sideboom tractors cradling the pipe and a third D8 towing the welding sled and available for extra pipe handling when necessary. A D8 bulldozer was used for backfilling and cleanup. Although asphalt dope was used, which normally is slow-setting, the wrapped pipe was lowered in by the catch-off tractor on the dope gang to avoid extra skidding, and this method worked without any hitches.

Processing Plant and Compressor Stations

The largest auxiliary facilities job likely ever to be undertaken on a single location in Canadian gas pipelining is nearing completion at Taylor, British Columbia. This includes the gas processing plant and the No. 1 compressor station with its enormous pumping equipment. The gas processing plant was contracted to Stearns-Roger-Marwell, a joint venture operation of Stearns-Roger Engineering Company, Ltd., and Marwell Construction Company, Ltd. The No. 1 compressor station was let to the same firm. The other three compressor stations, comprising all the other odd-numbered installations, were let to Dutton-Williams-Stearns-Roger, a joint venture of Dutton-Williams Brothers, Ltd., and Stearns-Roger. R. R. (Bob) Warner of Marwell is general superintendent and E. V. (Moon) Mullins of Stearns-Roger is project manager at Taylor. Main foundation work was completed on all projects except station seven during the 1956-57 winter, and buildings were essentially closed in at the station sites. Piping and electrical work were carried on to a considerable extent during the winter with heating facilities in operation.

The processing plant is designed for initial capacity of 400,000,000 cu ft a day, but inherent in the plans is provision for an increase to 650,000,000 cu ft per day. Integrated with it, although on a separate location on the general site, is a small refinery containing a Unifiner and a Platformer, to be operated on liquid by-products of the processing plant.



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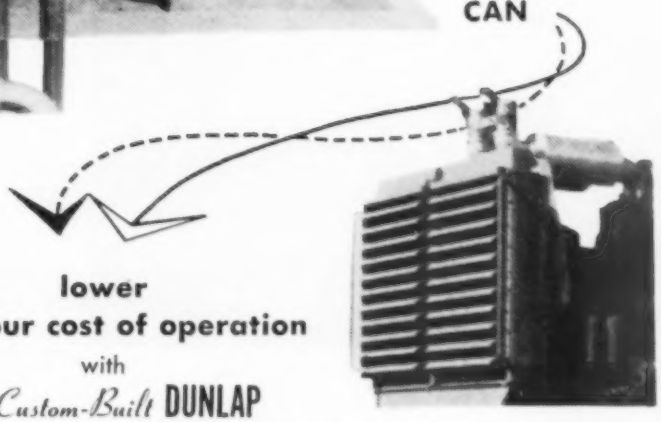

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Pipe strung along a typical right-of-way in the interior of British Columbia.

Suspension bridge across the Thompson River at Savona.

Making ditch with a backhoe.

The gas treating plant, which will deliver 65 percent of the entire line feed, is designed for continuous operation regardless of maintenance schedules. The gas scrubbing facilities are divided into five separate units, each operating independently. Only four are to be operated initially, so that one will be available continuously, in rotation, as a spare. The dehydration plant consists of four solid bed desiccant contactors, which will operate on a staggered eight-hour cycle with automatic switching. Any two contactors can maintain proper dew point of the gas at the designed load, so that there is complete 100 percent spare capacity.

Because of the severe winter climatic conditions, with minimum temperatures down to minus 60 F for at least a few days every season, and as much as 11 ft of frost in the ground, all process equipment except fired heaters and the Platforming and Unifiner reactors, have to be housed. Buildings are designed and built for maximum ease of servicing. A 20-ft walkway is provided in the center, with a traveling crane over it and equipment laid out along both sides. Construction style is rigid frame or truss. Buildings are sheathed with corrugated aluminum and insulated with a 2-in. glass fiber sandwich. They are constructed for a snow load of 40 psi and a wind velocity of 100 mph. They are capable of being heated to 40 F inside when the outside temperature is minus 40 F with a wind at 25 mph.

A special feature of construction is the water pump house, situated on the river bank below the plants. Initial cooling water requirements are 25,000 gal per min, or 36,000,000 gal per day, and the system will operate on a once-through flow, deleting cooling tower requirements. The pump house building is 90 ft by 30 ft, on a deep concrete foundation. The pump suction pit is built in two sections to provide for operation of one side while the other is being worked on or serviced. A system of stop logs is provided at the intake, to permit selection of water from any level. To avoid the possibility of the house being lifted by water pressure and buoyancy if no water was in the pit, extra bulk was included in the foundation design.

Five 6000-gal per min vertical closed impeller pumps were installed. Four are to be driven by 700-hp electric motors. The fifth will utilize the returning cooling water on a 190-ft head from the top of the slope to run a 700-hp turbine.

A unique feature of the entire site for the compressor station, gas processing plant, and refining units, as well as the tank farm, is that the entire river bench on which it is situated is a gravel

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bed, so that all the aggregate for the vast amount of concrete used in the construction was excavated right on the site. There was also no problem of obtaining a good base for the foundations, and maximum depth of building foundations is 6 ft, whereas water lines are buried 8 ft deep but only for frost protection. Drainage is excellent through the gravel bed to the river. A sulfur recovery plant, to be operated by Jefferson Lake Sulphur Company under agreement with Westcoast, is included in the construction program.

Because of the high silt content of the Peace River, which provides water for the plant, full backwash facilities have been installed on all units in the processing plant, to wash out silt and any other foreign matter. Actually, however, the flow velocity should be high enough to prevent any settling out of silt in the lines, and the designed facilities are considered mainly precautionary.

The main compressor station has been built with an unusual arrangement of by-pass lines because of the mixing of the two streams of gas, the direct-fed dry pipeline specification gas from the Alberta line, and the processed gas from the British Columbia line via the plant. Alberta gas can go directly into the 30-in. main line without going through the compressor station.

The station contains three input scrubbers handling sweet gas from Alberta, which normally will go through the compressors and back through two outlet scrubbers. Four coolers are provided to reduce the temperature of the outgoing gas from 160 F after compression to 100 F for the pipeline. A single control panel handles all control operations for the station. Heating system includes three small hot water boilers.

Six compressors are installed, of 2000 hp each, and a block has been poured for a seventh, which will be installed when throughput requires it. The compressors are gas-driven reciprocating models. Valves on discharge and suction lines are all automatic. The 12-in. suction and 10-in. discharge line valves are operated from inside the compressor housing.

A separate water pumphouse has been built to provide cooling water for the compressor jackets in a closed system.

Painting of lines for identification is being done in the case of air, fuel gas, and instrument air only.

The three smaller compressor stations are being constructed on much the same pattern, but the equipment consists of 24 by 24-in. single-stage centrifugal compressors driven by 3500-hp 4-cycle V-type spark-ignition gas engines operating on line feed. An interesting construction feature imposed by the lack of rail facilities down the right-of-way was the 75-mile winter road haul of the four engines for the No. 3 compressor station at McLeod, at the foot of Pine Pass. The engines were trans-shipped from the end of steel at Shelley, near Prince George, and hauled on large sleds by tractors. For safety on the snow-covered winter road, an additional tractor was winched on behind to hold back the load on downgrades and an extra tractor in front provided more pulling power for the upgrades. An average speed of 12 miles per day was maintained on this haul.

This station, and the No. 7 station at Savona, where the main takeoff is located for the distribution system of Inland Natural Gas Company in the interior British Columbia towns and cities, will start operations with four units each, whereas the intermediate station No. 5 at Australian will start more or less as a booster station with three units.

Canadian Bechtel, Ltd., has been the engineer, designer, and supervisor of construction throughout the project, with Henry Mogg as general superintendent, under R. L. Bowman as manager of construction and H. F. Waste as project manager. Ford, Bacon &

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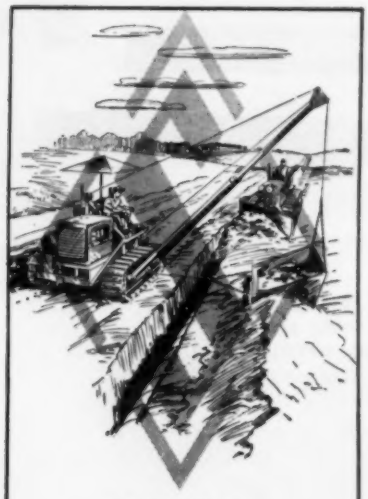

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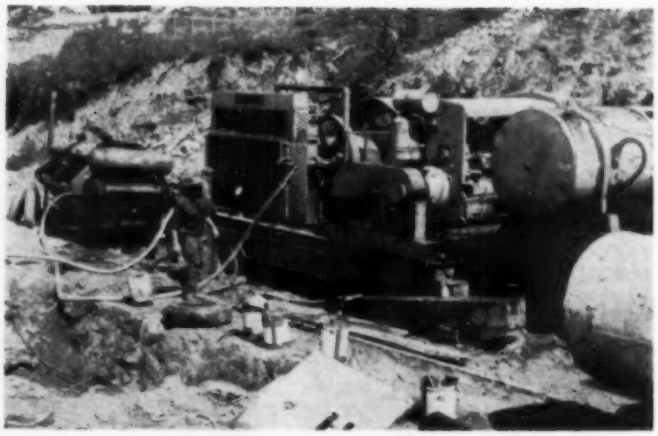

Compressor hookup for testing section of line.

Davis Canada, Ltd., designed the compressor stations and metering facilities.

Because of the remote locations of so much of the construction work, camp organization with professional catering service was used for the northern section of the project. At Taylor the main camp of Stearns-Roger-Marwell housed as many as 900 men at the peak. Catering was done by Canus Services Alberta, Ltd., a company whose efficiency on the Alaska Products Pipe Line job in 1954 won it a lasting reputation for construction camp work. Although built by contractor, the camp was designed entirely by Canus engineers and constructed on the site in the summer of 1956.

All bunk house accommodations consisted of double rooms, no dormitories, with the "H" shape of the buildings permitting a central wash and shower room in each unit. All units were fully air conditioned for summer, using the same ducts and blowers that provided heat in the winter. Both heat and cooling were regulated by automatic thermostats. This arrangement was greatly appreciated by the men in a climate with a maximum temperature range of 160 deg between summer and winter.

Subsidiary camps were operated by Canus for Canadian River Construction and Dutton-Williams, and they were designed for extreme portability so that a move of the complete camp could be made between breakfast and evening dinner without a hitch. ★ ★ ★

"Better take me off that river crossing job, ... my wife's blowing her top-"

The Pipeline That Saved a Community

Crossing of Red River from Montague County, Texas, to Oklahoma side is shown early this spring while construction was going on. Crossing was completed August 17.

Gas line from Jack and Wise counties, Texas, gives outlet for more than 100 shut-in wells and provides a new economy in drought area

NATURAL GAS Pipeline Company of America's pipeline from Jack and Wise counties, Texas, might well be called a project that saved a community economically. For seven years ranchers and farmers of the area suffered from a severe drought — one of the longest and worst ever experienced in Texas. Grazing lands were dried up, making it necessary for ranchers to sell off their stock, keeping only basic herds. Watermelons, the principal local product, were shrivelled and unmarketable.

It was a heart breaking situation, made more so because on most of the ranches there were producing gas wells but they were shut-in. So, with the means of comfort within reach, many were in want.

Why were the wells shut-in?

Two years before final approval came through last December, Natural Gas Pipeline Company of America had applied to the Federal Power Commission to construct a 350-mile pipeline to take the gas from a point near Bridgeport, Texas, through Oklahoma, into the company's main line at Fritch in the Texas Panhandle. But there were several interveners. One company proposed to build a pipeline itself. It was contended, also that the price agreed to pay landowners, 15 cents a thousand cubic feet, was too high.

Finally, on December 4, 1956, FPC handed down a decision giving NGPL permission to construct the line. First, however, it was necessary to renegotiate contracts with landowners for payment of 14 cents per Mcf instead of 15 cents, as FPC considered the latter too high.

Construction began almost immediately and the project is scheduled for completion late in November.

The area from which the gas is being taken is reputed to be the largest uncommitted gas reserves in North America, being placed at 2½ trillion cu ft. Christie, Mitchell, and Mitchell of Houston developed the area following an agreement with John A. Jackson and Ellision Miles of Dallas, who drilled the discovery well. When the

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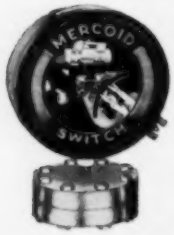

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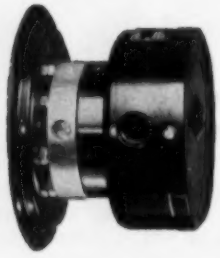

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Aerial view of completed soil erosion dam, one of 13 built on the extension line and completed last June. The dams, horseshoe shaped in order to meet the desired contour line of the terrain, were built over gullies to control further erosion and reclaim the gullied area above it. Line will cross near the dam.

FPC permit for construction of the pipeline was given there were 112 producing wells drilled of which 108 were shut-in. For 1957, the drilling program calls for 150 wells. This should mean a lot of producing wells because CM&M has a record of 10 producers for every dry hole so far, reversing the usual average for oil and gas drilling.

Initially, the line will move 127,000,000 cu ft of gas a day. Of this total, 92,000,000 cu ft will come from wells in Jack and Wise counties. An additional 35,000,000 cu ft will be received from Lone Star Gas Company, to be delivered to NGPL in Stephens County, Oklahoma, near Duncan.

Eastern Construction Company of Dallas is laying 88 miles of the 20-in. from Bridgeport to Oklahoma, at a point in northern Carter County.

From northeast Carter County, northwest through Stephens, Grady, and Caddo counties, terminating in northeast Kiowa County, Oklahoma, H. B. Zachry Company of San Antonio is laying 85 miles of 26-in. This is the second segment of the system.

The third and fourth segments of the project, awarded to River Construction Corporation of Fort Worth, consist of 173 miles of 26-in. from Kiowa County through Washita and Beckman counties, Oklahoma, Wheeler, Gray, and Carson counties, Texas, to a point near the company's main line station at Fritch, Texas.

Trend Construction Company of Oklahoma City reworked the piping systems at Fritch and Stinnett stations to take care of the new load.

Whitmor Homebuilders, Inc., of Tulsa is building cottages for field personnel, warehouses, an office building, and facilities for a radio and tower building at the Wise County station. At Wheeler, Texas, and Sentinel, Oklahoma, a warehouse and cottages are being constructed, as well as a warehouse

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One of 13 aerial crossings on the line. Because the terrain was severely eroded, lines had to be constructed over it.

After finish weld is made, and before line is lowered-in, the weld is inspected to insure that it meets company specifications.

at Duncan and nine cottages at Bridgeport.

Besides the 360-mile main line, an extensive gathering system is being installed in Jack and Wise counties by Fulton and Brodie, Inc., of Lubbock. This consists of 135 miles of 4-in. through 20-in. pipe, and 86 meter stations.

As a preliminary part of the project, 13 soil-saving, erosion control dams were built in Wise and Montague counties, Texas. The terrain in these two counties is badly cut up by gullies caused by water erosion during the 1920's when a 15-in. rainstorm played havoc with the land.

Attempts at intensive farming, backfurrows at edges of once-cultivated areas, deadfurrows, row crops, early terraces that failed, and over-grazing each have contributed to the severe erosion.

Prior to undertaking the dam building project, NGPL made extensive surveys of the area's needs in relation to protection of the pipeline. The state conservation service and the U. S. Conservation department, both at Bridgeport, were consulted.

Studies began as early as 1954. James G. Hill, U. S. Soil Conservation Department construction engineer at Bridgeport, and L. J. Lann, design engineer, Denton, worked with representatives of NGPL on the surveys.

Acting upon the advice of these groups and previous company experiences, it was decided that the soil-saving drop inlet type of dam would be most beneficial to both landowners and the company.

This type of earth dam was built in the gullies to control further erosion and to reclaim the gullied area above it. The dams are horseshoe-shaped in order to meet the desired contour line of the terrain.

Pittsburgh-Des Moines Steel Company of Des Moines, Iowa, installed 13 aerial pipeline crossings to bridge the erosion control dams. Nine were on the main line and four on the gathering system. ★ ★ ★

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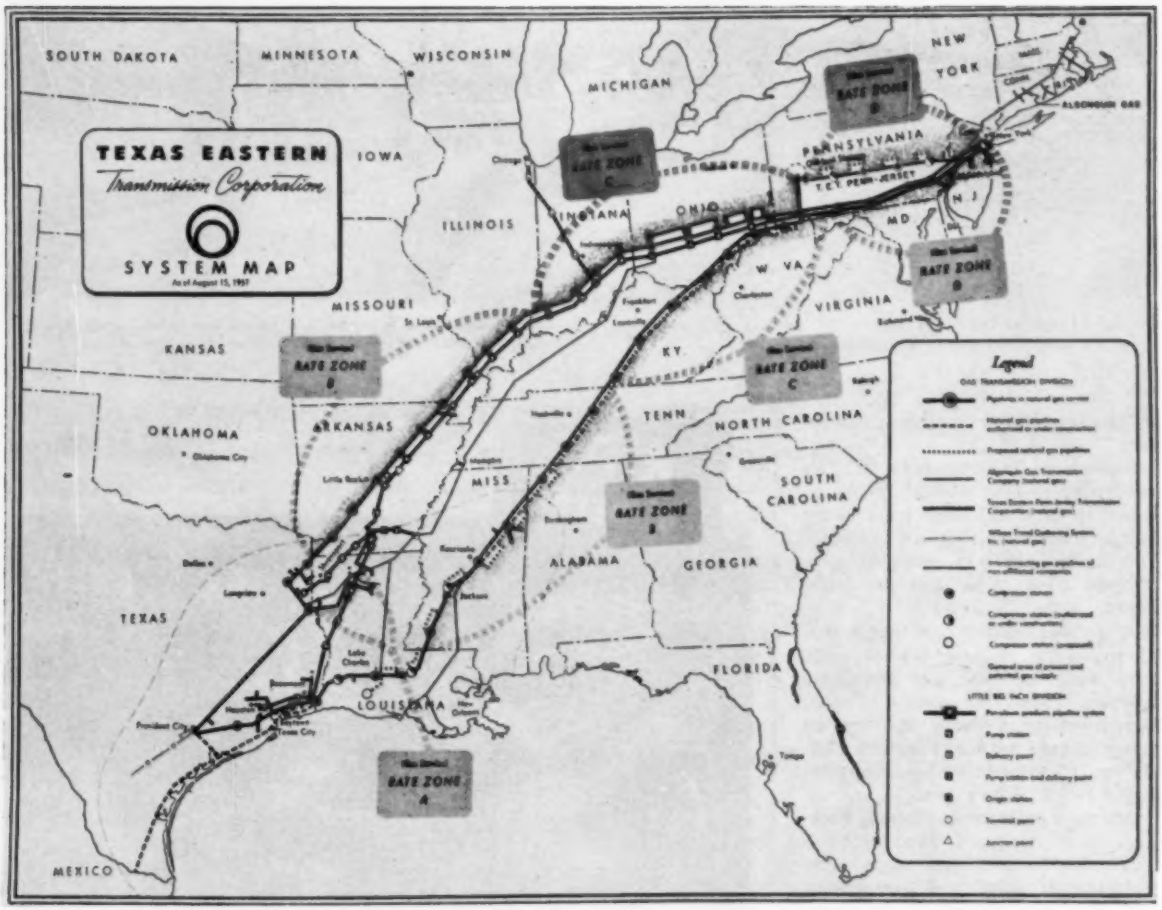

Import of Mexican Gas By Texas Eastern a Highlight of the Year

Initially 126,000,000 cu ft a day is crossing border near McAllen, Texas — Company has other extensive projects completed, underway, and planned

AN EVENT of great historic significance marked construction activities on Texas Eastern Transmission Corporation's natural gas pipe line system during 1957. On August 22 natural gas began flowing into the United States from Mexico — the first major importation by a long distance pipe line company.

Construction of this pipe line was begun in October 1956 and completed in time for the line to go into operation in August 1957. The line is a 30-in. diam pipe line extending from the international border on the Rio Grande below McAllen, Texas, along the Texas Gulf Coast to the company's Vidor compressor station near Beaumont. There it is connected with Texas Eastern's 30-in. line that reaches up into Pennsylvania.

Initially Texas Eastern will take 126,000,000 cu ft of gas per day from Mexico with provisions for this amount to be increased to 200,000,000 cu ft per day as new reserves are developed. This is part of an expansion program which will add 360,000,000 cu ft to

Orville S. Carpenter (left) shakes hands with Sr. Jose Colomo at the site of the valve turning ceremonies recently held on the Mexican border marking the first importation of natural gas into the United States from Mexico. Carpenter is president of Texas Eastern Transmission Corporation, importer of the gas, and Colomo is vice president of Petroleos Mexicanos, exporters of the gas. Olin Culberson, chairman of the Texas Railroad Commission is to the left of Carpenter.

Welders join giant sections of pipe on the flat prairie land of the Texas Gulf Coast during construction of Texas Eastern's natural gas pipe line that extends from near Beaumont to the Mexican border.

Texas Eastern's daily delivery capacity by fall, bringing total system capacity to 1,634,000,000 cu ft.

The gas being imported is coming from the Brasil, Trevino, and Lomitas fields in northeastern Mexico. Processed at the Pemex natural gas processing plant at Reynosa, the gas is being delivered from the plant into Texas Eastern's system at the border on the Rio Grande.

Six small diameter natural gas pipe lines and two loop pipe lines of small diameter were completed during 1957. Lines completed total approximately 220 miles in sizes ranging from 3 to 12 in. in diam. They were constructed in Texas, Louisiana, and Pennsylvania.

One major new line is under construction, a new 14-in. products line from Seymour, Indiana, to Chicago, a distance of some 230 miles. Two new lines have just been completed, the previously mentioned 30-in. line from McAllen, Texas, to Vidor, Texas, and a 24-in., 45-mile lateral from the McAllen-Vidor line at Provident City, Texas, to Blessing, Texas. This line has recently been completed and placed in service.

Sideboom tractors are dwarfed by towering sides of the ditch required to lay pipe across the Rio Grande to connect Texas Eastern's system with facilities of Petroleos Mexicanos. Crossing is just below McAllen, Texas.

"WE HAVE SOME PRETTY NICE TERRAIN TO GO THROUGH, - I BROUGHT YOU A SAMPLE."

Three major loop line projects are under construction. One includes some 626 miles of 30-in. loop lines between Kosciusko, Mississippi, and Uniontown, Pennsylvania, on the company's 30-in. natural gas trunk line, and the other two are smaller diameter loop lines in Pennsylvania totaling 16 miles.

The company plans to construct approximately 250 miles of additional 30-in. loops between Vidor, Texas, and Kosciusko, Mississippi, and between Kosciusko and Uniontown, Pennsylvania. Also a new 14-in. diam line will be built in south Louisiana and will cover a distance of 22 miles.

The company is awaiting Federal Power Commission approval on a 65-mile 30-in. loop between Delmont, Pennsylvania, and Lambertville, New Jersey, on the line of its wholly owned subsidiary, Texas Eastern Penn-Jersey Transmission Corporation.

During the past year, Texas Eastern has completed five new compressor stations on its 30-in. trunk line and is nearing completion on four new compressor stations along the same line. Projects adding compressor horsepower to four compressor stations have been completed and additions at four other existing compressor stations are nearing completion. The company, at the present time, has only one new compressor station in the planning stage but authorization has not been received to construct this facility.

Texas Eastern's wholly owned subsidiary, Texas Eastern Penn-Jersey, has completed addition of horsepower at two stations, is in the process of adding horsepower at three other stations, and has construction under way on two new stations. Federal Power Commission approval is being awaited on an addition to another Penn-Jersey compressor station.

The company expects all of its presently authorized or planned construction programs to be completed by 1958. ★ ★ ★

Pipeline Personals

A. E. Pecore, vice president of Humble Pipe Line Company, has been named president of the company. The election of Pecore was in anticipation of the September retirement of **O. Q. Lomax,** who has been president of the company

A. E. Pecore

O. Q. Lomax

since 1950. **William S. Spangler,** who has been serving as general superintendent, replaces Pecore as vice president. **P. D. Phillips Jr.** has been promoted to general superintendent and has been named a director of the company. Lomax went to work for Humble Oil & Refining Company in December 1918, and transferred to Humble Pipe Line as an engineer-draftsman in the spring of 1919. In 1942 he was made vice president and general manager of the company and elected to the board of directors. Eight years later he became president. Pecore served four

W. S. Spangler

P. D. Phillips Jr.

years' service with the Southern Pacific Railway and joined the engineering department of Producer's Oil Company, now The Texas Company. In 1919, after service in the army, he joined Humble Pipe Line as a draftsman in the Houston offices. In 1950 he became vice president. In 1933 Spangler went to work for Humble Pipe Line as a pipeliner in the East Texas division. He has been a general superintendent of the company since 1951 and was appointed a director in 1955. Several months after Phillips' graduation (1934) he went to work as a pipeliner for the company at Longview. He was promoted to assistant general superintendent in January 1956.

Charles E. Putman Jr. was appointed to the newly created post of field superintendent of Lone Star Gas Company's compressor department. He will supervise and coordinate operations of all transmission, field and underground gas storage compressor stations operated by Lone Star in Texas and Oklahoma. He formerly was superintendent of the Joshua compressor station in January 1950. His successor as plant superintendent is **Seth Davis. Harold C. Brawner** has been appointed assistant superintendent of the Joshua compressor station. Also announced was the change in classification of **James G. Elder** from repairman B to repairman A at the Joshua plant.

L. J. White has been promoted from district superintendent of Magnolia Pipe Line Company's Houston-Beaumont district to division superintendent of the southern division. He has been moved from Beaumont to Houston. **R. E. McDonald** has been transferred to Alice, Texas, as district superintendent of the southwest Texas district. **Homer Cranfill** has been transferred to Wichita Falls, Texas, as district superintendent of the North Texas district. He was formerly district superintendent of the southwest Texas district. **J. R. Dean** has been transferred to Beaumont as district superintendent of the Houston-Beaumont district. He was formerly district superintendent for the North Texas district at Wichita Falls. **L. A. Foy** has been promoted from district superintendent of the West Texas district at Midland to assistant division superintendent of the western division. **J. J. Harris** has been transferred to Midland to replace Foy as district superintendent of the West Texas district.

Joseph D. Harnett of St. Louis, Missouri, vice president for transportation of The Standard Oil Company (Ohio), has been named assistant to **Clyde T. Foster,** president of the company in Cleveland, and continues as a vice president of the company. **Henry W. Pattison,** general superintendent of transportation operations, has been named manager of the transportation department. These promotions follow the recent assignment of **Richard S. Stewart,** who had been vice president and assistant to the president, as vice president for production.

J. D. Behling has been promoted to division chief engineer in the West Texas division, headquarters at Lubbock, Service Pipe Line Company.

M. C. McNichol, of Lubbock, oil traffic engineer, was promoted to assistant supervisor of oil movements in the Tulsa office, replacing Behling.

David W. Peake has been made a full partner of S. D. Day Company, Houston. Peake joined the firm in 1950, and spent his first four months obtaining practical experience in the field with pipeline crews. Subsequently, he became sales manager responsible for all marketing operations including advertising, promotion and public relations.

D. W. Peake

Howard Boyd

Howard Boyd has been elected to a newly created post of executive vice president, El Paso Natural Gas Company. He has been a vice president and assistant general counsel of El Paso since he joined the company in August 1952, and has been a member of the firm's board of directors since early 1953. He is vice chairman of the board of Pacific Northwest Pipeline Corporation, and an officer and director of other subsidiary companies of El Paso.

Don R. Ford, vice president and former assistant manager, has been named manager of Magnolia Pipe Line Company. **J. E. McGeath,** formerly general superintendent, was appointed assistant manager. Succeeding McGeath as general superintendent will be **M. E. Powell,** who has been serving as assistant general superintendent. Ford was elected a director of Magnolia Pipe Line on March 13, 1951, and made vice president on March 11, 1952. McGeath

D. R. Ford

M. E. Powell

J. E. McGeath

has served as a director of Magnolia Pipe Line since March 1956. Powell, since September 1, 1955, has been located in Dallas as assistant general superintendent.

O. G. Howe, engineer on the general office staff of the Oklahoma Natural Gas Company in Tulsa, has been promoted to mechanical supervisor, compressor stations. Howe replaces **D. R. Alley** who retired from the company.

A. J. Le Blanc has been promoted to coordinating engineer by Pipe Line Technologists, Inc., Houston, Texas. He has served as engineering officer for the United States Navy at Oak Ridge, Tennessee, in connection with the Atomic Energy Program and as chief electrical engineer for Wyatt C. Hedrick Engineering Corporation, Houston, Texas.

Ralph H. Starrett has been named manager in charge of a products pipeline division that will be based in Kansas City, Missouri, Standard Oil Company (Indiana) announced.

Also announced was the appointment of pipeline and mechanical division superintendents at the company's three division products pipeline offices. Named to the new pipeline division superintendent posts were **Francis W. Mann,** Chicago; **James L. Ashworth,** Kansas City, and **Herbert W. Wilker,** Minneapolis-St. Paul, Minnesota. All three formerly were district superintendents, with Mann at Council Bluffs, Iowa; Ashworth at Moorhead, Minnesota; and Wilker at Jackson, Michigan. Mechanical division superintendent assignments went to **Alvis F. Smith,** Chicago; **Hugh Patterson,** Kansas City; and **Virgil J. Hansen,** Twin Cities. They formerly were division master mechanics. Division managers, in addition to Starrett, are **Spencer A. Hallberg,** Chicago, and **Norman F. Tietze,** Twin Cities. Their title formerly was division superintendent.

Audley E. Harnsberger has been elected president of Pure Transportation Company, wholly owned pipeline subsidiary of the Pure Oil Company. He succeeds **J. W. Meehan,** resigned.

Personals

J. W. Meehan

▸ **Joseph W. Meehan** has been named vice president of Derby Refining Company, Wichita, Kansas, with responsibility for transportation and crude oil supply. Meehan, for 25 years, has been associated with The Pure Oil Company, Chicago, most recently as general manager of their crude oil purchasing division, and as president of Pure Transportation Company and president of Arapahoe Pipe Line Company. Derby Refining is the refining and marketing subsidiary of Colorado Oil and Gas Corporation.

▸ **Robert M. Chan** of Dallas, Texas, has been elected to the board of directors of Transwestern Pipeline Company. He not only will serve as a board member, but also will be an advisor to the new gas pipeline corporation, particularly in connection with gas procurement, with offices in Dallas, Texas. Chan retired September 1 as first vice president of Magnolia Petroleum Company of Dallas after 22 years' service.

▸ **Wyatt Norman** has joined Trunkline Gas Company, Houston, as district landman with headquarters in Corpus Christi, Texas. He formerly had served as manager of the land department of Reynolds Mining Company. In his new position with Trunkline Gas, he will be in charge of land department activities in the Corpus Christi district.

▸ **J. C. Brown** has been appointed chief operator-deliveryman at Roseville, California, by Southern Pacific Pipe Lines, Inc. **T. T. Hendrix** has been named to the same post at Reno, Nevada; **J. G. Sparks** at Concord, California, and **J. E. Owen,** at Colfax, California. **J. W. Sims** has been made assistant chief operator — deliveryman at Phoenix, Arizona, and **L. F. Lee** has been appointed to the same post at Concord.

▸ **O. Q. Lomax,** recently retired as president of Humble Pipe Line Company, has announced the opening of a consulting office at 310 Esperson Building, Houston, Texas.

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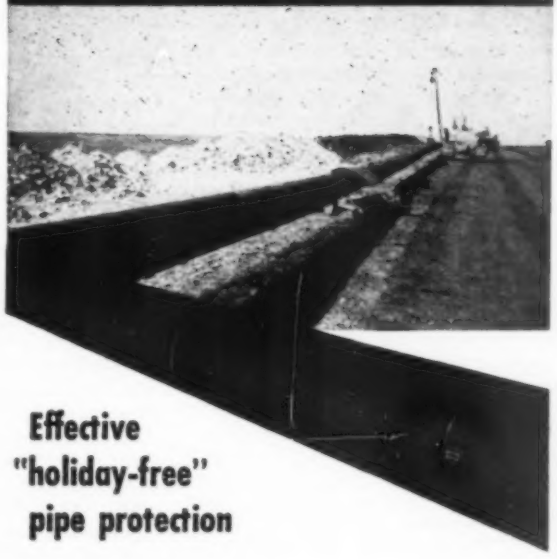

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Sealtight Pipe Shield provides an easily workable protective shield for pipes in every type of terrain or installation. It is the one completely effective and economical answer to "holiday-free" pipe shielding . . . eliminates the expense of dirt padding. Penetration tests show that even large rocks fail to rupture this material. Ideal for protecting pipe sections pulled across swamps . . . replaces ineffective, costly wooden slats or snow fence materials in shielding coated pipes at river crossings and under river clamps. Sealtight Pipe Shield is impervious to stress and strain of soil movements—unaffected by soil chemicals and moisture. Records of on the job tests prove Sealtight Pipe Shield far more effective and less costly than ditch padding installations.

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It Pays to take care of your CABLE

By the nature of its use cable must be replaced frequently, but proper care and maintenance will make it last longer and save many dollars each year

J. B. Sinclair
Service Department
Caterpillar Tractor Co.
Peoria, Illinois

Careless handling of cable causes kinking. Worn cable, such as the example shown here, not only means that it must be replaced prematurely, but presents a hazard to safety as well.

HERE is what happens inside a cable as it bends when passing over a sheave and then straightens out while moving to the next sheave.

The individual wires are preformed in what might be thought of as a long spiral and twisted together into strands. The strands are twisted together into a rope. This construction permits great flexibility without excessive "stretchiness" and minimizes friction between wires as the cable bends and straightens. In operation, a cable is a group of closely fitted moving parts.

Cable, like any other part of a machine requires reasonable care. Its service life can be shortened by abuse or lengthened by proper use and maintenance.

It is not at all uncommon to see a reel of cable rolled over an obstacle with the cable taking the brunt of the shock, or to see a pry bar being used to move a reel of cable. Whenever this occurs, some of the life is taken out of the cable before it is ever put to use.

Sharp bends or kinks in a cable are frequently the cause of rapid wear. When bent or kinked, the wires and strands are moved out of their relative positions and unequal tensions are created on individual wires.

Kinks are caused by careless handling of the cable either on or off the machine. When unreeling or uncoiling cable from a reel, pull the cable straight away from a rotating reel. Do not let the reel rotate faster than the cable is being removed as the danger of kinking is increased considerably. When cable is removed from a reel that does not rotate, uncoil the length of cable required, placing one coil on top of the other. The cable can then be moved easily to the job site and installed without kinking.

Here are some other important facts to remember when installing new cable:

Always be sure to use the correct cable size.

Weld or otherwise bind the end of the strands of cable together. In this way, the strands are held in their relative positions and cable wear will not be excessive because of loose, high strands that have moved out of position.

The strands of the cut-off end of the reel also should be secured and the end of the cable secured to the reel. Do not drive nails through the cable to secure it to the reel as wires can be damaged or broken and the cable weakened.

When installing new cable, assemble the cable on the drum in the direction of the natural coils. If installed correctly the cable will have a greater tendency to reel onto the drum in a smooth layer.

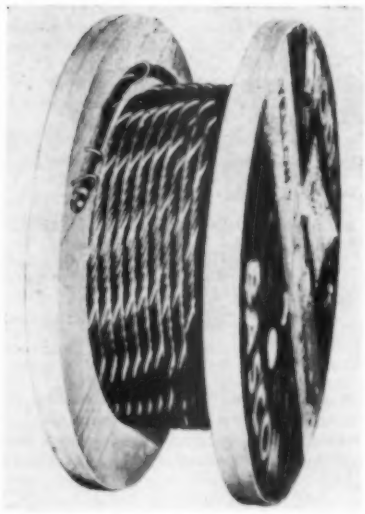
Keep Cable Clean and Lubricated

Proper lubrication of cables will extend cable life, promote safety, and reduce downtime. The frequency of cable lubrication depends largely on operating conditions. If operating in dusty conditions, the cable should be lubricated sparingly, if at all, since dust will adhere to lubricant and cause wear on both cable and sheaves. Cable lubrication is recommended in areas where atmospheric conditions support rusting and corrosion. A film of lubricant definitely will extend cable life.

To prevent rusting, cable lubricants should be water resistant, contain no acids or alkalies, and have a high surface tension. Each time a cable is flexed, the wires in each strand and the strands that make up the cable must slide over each other. For this reason, a penetrating, clinging lubricant of high melting point such as "crater compounds" — used for open gears and cables on shovels or cranes — should be used. In the event of an extended or seasonal shutdown, the cable should be cleaned and well lubricated. Sheaves and rollers should always be kept clean and well lubricated to facilitate free turning, and minimize sliding wear on the cables.

Avoid Cable Strain

Properly maintained equipment means extended life for all parts concerned. Inspections to determine op-



Fraying is prevented by welding the end of the cable.

erating conditions and the replacement of worn or broken parts is economy and not a waste of time or money.

The operation and maintenance of cable controlled equipment determines, to a large extent, the life of a cable. Misaligned sheaves, bad sheave grooves, and frozen (non-rotating) sheaves can reduce cable life by causing burning and eventually fraying. Whenever there is excessive friction between the cable and the other parts of a machine, burning usually results. Burned cable soon becomes brittle and cracks. Cracked wires soon lead to frayed strands and a weak spot in the cable.

The useful life of cable also can be reduced by operating over sheaves that shimmy. Shimmy is caused by worn sheave bearings and results in rope vibration, which causes steel fatigue.

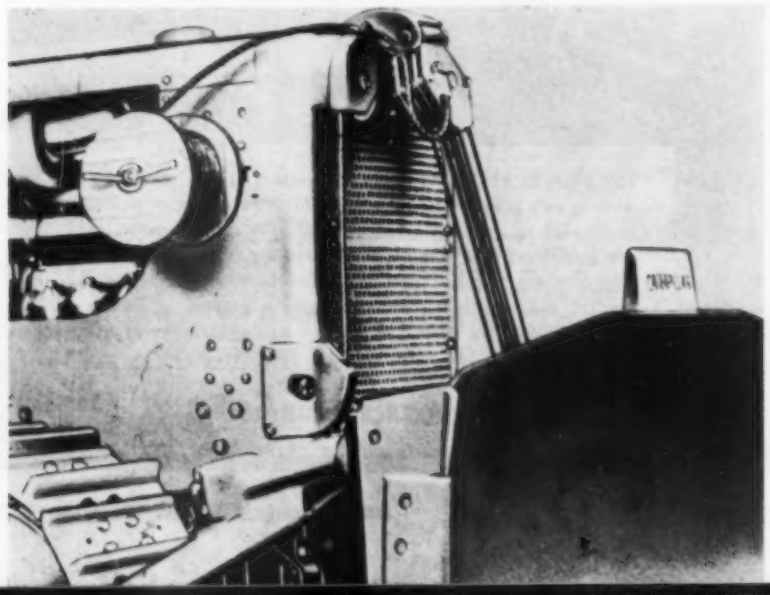
After installing a new cable, treat it as you would a piece of new equipment. Don't overstress it. Let it break in easy so that the individual wires and strands have an opportunity to stretch and position themselves in the sheaves and around the drum. Sudden starts or stops should be avoided. Jerking out slack can break even a new cable. "Bird caging" of the cable can result from sudden stops. The sudden reduction of tension weakens cable considerably.

In almost every application in which cable is used there are points at which wear is more rapid. Therefore, it is economical to reverse the cable, end for end, where wear becomes apparent.

Some owners have equipped their dozers with a small spare drum or reel of cable so only the length of cable needed can be quickly fed through the "dead end" to replace the length of cable cut off or broken. When cable wear occurs on the drum end, the "dead end" wedge can be removed and new cable pulled through the system far enough to eliminate the worn section. The worn cable, anchored to the control drum, can be cut off as necessary and the "dead end" wedge reinstalled. Also, by cutting off one or two feet of cable periodically, "fresh" cable is located at critical wear points such as where bends occur and over sheaves.

A similar method of obtaining maximum cable life can be used on scrapers. The reels, which are mounted on the scrapers, carry extra cable that can be pulled through the system with a sufficient distance to provide an unworn section of cable over sheaves. The worn cable on the cable control drum can then be cut off as necessary. ★ ★

A small spare reel of cable, mounted as shown, makes replacement of worn cable an easy task.



News

Home Gas to Enlarge New York Facilities

Federal Power Commission has granted Home Gas Company, Pittsburgh, Pennsylvania, temporary authority to construct and operate natural gas facilities in New York at an estimated cost of approximately $3,823,000.

Home Gas proposes to install and operate storage field lines and appurtenant facilities necessary to the activation and operation of an extension of its Dundee storage field in Schuyler, Steuben, and Yates counties; and to construct approximately 19.5 miles of 16-in. transmission line from Dundee compressor station to a connection with its existing east-west transmission system at a point in Steuben County.

Ohio Oil to Construct 85-Mile Products Line

The Ohio Oil Company has received from the Illinois Commerce Commission a Certificate of Public Convenience and Necessity to construct and operate as a common carrier a petroleum products pipeline from Robinson to Champaign, Illinois. The line will consist of 85 miles of 12-in.

Completion is scheduled for December of this year. The line will transport products from Ohio Oil's refinery at Robinson, as well as products of other companies, to a terminal under construction near Champaign. Light petroleum products including gasolines, home heating oils, kerosine, and diesel fuels will be shipped. The line will have an ultimate capacity of more than 90,000 bbl a day.

The Panama-Williams Construction Company of Houston, Texas, has been awarded the contract to build the line.

To Abandon Steam, Use Gas Engines at Station

Federal Power Commission has granted temporary authority to Atlantic Seaboard Corporation, Charleston, West Virginia, to install two gas-engine-driven compressor units at its Boldman station in Floyd County, Kentucky. The new compressors are to replace three steam-engine-driven units at the same station. Cost of the construction is estimated at $1,600,000.

Installed capacity at the Boldman station is now 8600 hp, consisting of three 2200 hp steam units and two 1000-hp gas units. Seaboard said that because of increasing coal and labor costs and because of decreased power requirements at Boldman, it was no longer economically feasible to continue the operation of the steam facilities.

WITH THE PIPELINE CONTRACTORS

● **Fulton Banister, Ltd., 625 Northern Hardware Building, Edmonton, Alberta.** Has 100 miles of 18-in. for *Alberta Gas Trunk Line Company, Ltd.*, from Burstall at the Alberta border to Provost, Alberta. Also has 22 miles of gas gathering line in the Provost field for *Provo Gas Producers, Ltd.*, consisting of constructing gathering system and wellhead tie-ins—3 to 12-in. pipe; this gas to be fed to Alberta Gas Trunk Lines.

● **Banister Construction, Ltd., 625 Northern Hardware Bldg., Edmonton, Alberta.** Has undetermined amount of 2 to 6-in. extensions to existing systems in cities and towns in Saskatchewan, plus approximately 5000 consumer service connections, for *Saskatchewan Power Corporation*. Has contract for construction of transmission and distribution system in the town of Wilkie, Saskatchewan, for the *Saskatchewan Power Corporation*.

● **Williams Brothers Company, National Bank of Tulsa Bldg., Tulsa, Oklahoma.** Has 212.5 miles 20-in. crude line for *Socony Mobil Oil Company de Venezuela*. Line will extend from San Silvestre field to Puerto Cabello on the Caribbean Coast.

● **H. C. Price Company, Box 1111, Bartlesville, Oklahoma.** Has 71 miles of 30-in. line for *Texas Eastern Transmission Corporation* in the Port Lavaca, Texas, area. Has contract for construction of 343 miles of 30-in. pipeline loops for same company, consisting of six jobs in Tennessee, Kentucky and Ohio.

● **Sheehan Pipe Line Construction Company, National Bank of Tulsa Bldg., Tulsa, Oklahoma.** Has 116 miles of 8-in. line for *Buckeye Pipe Line Company* between Huntington and Griffith, Indiana; project includes take-up, reconditioning and relay. Also has 70 miles of 8-in. line to recondition for *Buckeye Pipeline Company* near Cooks Ferry, Ohio.

● **Canadian River Construction, 580 Hornby Street, Vancouver, British Columbia.** Has 150 miles of gathering lines in northern Alberta and British Columbia for *Westcoast Transmission Company, Ltd.*

● **Troth Construction Company, Box 592, Britton, Oklahoma.** Has contract for 160 miles of 2 and 8-in. lines for gas distribution to communities in the Aberdeen, South Dakota, area, for *Northern Natural Gas Company*.

● **Engineers Limited Pipeline Company, 200 Bush Street, San Francisco, California.** Has line for *Pacific Gas & Electric Company* consisting of 37 miles of 20-in., 37 miles of 18-in., and 19 miles of 12-in. to lay from Beehive Bend field to Sacramento, California.

● **Mannix, Ltd., 322 Seventh Avenue W., Calgary, Alberta.** Has 100 miles of 3 to 12-in. gathering line in the Pembina field to lay for *Pembina Pipeline Company, Ltd.*

● **F. E. Shaw, Ltd., 530 S. Vidal Street, Sarnia, Ontario.** Has 40 miles of 6 to 10-in. line for *Dominion Natural Gas Company, Ltd.*, in the Brantford, St. Catharines, and St. Thomas districts. Has 8 miles of 16-in. line for *Dow Chemical of Canada, Ltd.*, from new salt bed location to the Sarnia district. Has 14 miles of 16-in. loop line around the city of Hamilton, Ontario, for *United Gas and Fuel Company*. Has 67 miles of 6 to 20-in. transmission lines for *Union Gas Company*, Chatam, Ontario, to Dawn, London, St. Marys, Stratford, Kitchener and Guelph.

FOR OVER 20 YEARS the versatile Cleveland "110"...here's one working on a gas gathering line for Phillips Petroleum in McClain County, Okla.... has been a fast dependable trencher on gas, oil, and product pipelines of all types, to 24 inches wide and 5½ feet deep ... trunk lines, gathering lines, field lines, lease lines. Built tough and compact, the "110" is a perfectly balanced combination of practical, performance-proved features ... a trencher of superior digging ability in all types of soil and terrain. It digs more trench in more places at less cost.
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FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

● **Engineering-Construction Company, First National Bank Building, Tulsa, Oklahoma.** Has contract with *City of Macon, Missouri*, to lay 25 miles of 4 and 6-in. between Moberly and Macon, Missouri, and 12 miles of various size distribution lines in Macon.

● **C. P. Bartley & Son Pipe Line Construction, P. O. Box 616, Tioga, North Dakota.** Has 121 miles of 2 through 12-in. gas gathering extensions for *Signal Oil & Gas Company* in the Newton, North Dakota, area.

● **Houston Contracting Company, 2707 Ferndale Place, Houston 6, Texas.** Has 80 miles of 30-in. gas line for *Texas Eastern* from Kosciusko to Egypt, Mississippi. Has 80 miles of 30-in. natural gas line for *Northern Ontario Pipe Line Crown Corporation* between Uspala and Port Arthur, Ontario. Also has 33 miles of 6, 8, and 10-in. lateral gas lines for *Tennessee Gas Transmission Company* in the vicinity of Southwest Pass below New Orleans, Louisiana. Has 20 miles of 18-in. natural gas line reconditioning for *Texas Gas Transmission Corporation* near Bastrop, Louisiana.

● **Dutton-Williams Brothers, Ltd., North Canadian Oil Building, Calgary, Alberta.** Has 60 miles of 30-in. natural gas line from Kenora, Ontario, eastward for *Northern Ontario Pipe Line Crown Corporation*. Has 120 miles of 30-in. line for *Trans-Canada Pipe Line Ltd.*

● **Fish Service Corporation, M & M Building, Houston, Texas.** Has 67 miles of line for *Florida Pipeline and Storage Company* from Port Everglades to Homestead Air Force Base, Florida.

● **Dunn Bros., Inc., 801 Mercantile Securities Bldg., Dallas, Texas.** Has stringing contract with H. C. Price Company on 69 miles of 12-in. line for *Texas Eastern Transmission Company* between Chicago and Ashton, Illinois. Also has similar contract with same companies for stringing approximately 230 miles of 30-in. in Alabama, Tennessee, and Kentucky. Is stringing 32.5 miles of 30-in. for *Tennessee Gas Transmission Corporation* between Winchester and Richmond, Kentucky. Is stringing 76.5 miles of 16-in. between Aneth, Utah, and Kayenta, Arizona, and 86 miles of 12-in. between the Mesa station in Utah and the Bisti oil field in New Mexico for the *Four Corners Pipeline Company* (the A. P. V. Company is prime contractor). Will string 27.5 miles of 34-in. near Leupp, Arizona, for *El Paso Natural Gas Company*. Will string 85 miles of 14-in. between Columbus and Lebanon, Indiana, for *Texas Eastern Transmission Corporation* (H. L. Gentry is prime contractor). Also has 93 miles of 14-in. between Lebanon and Schnieder, Indiana, for the same company with Latex Construction Company acting as prime contractor.

● **R. H. Fulton & Company, Inc., P. O. Box 1526, Lubbock, Texas.** Has sections 3, 5 and 6 of *Four Corners Pipe Line Company* line. Section 3 is a 16-in. line 98 miles long from Cameron to Seligman, Arizona; this work began July 1. Sections 5 and 6 are to begin October 15 to avoid crossing desert during hot summer. Section 5 is 105 miles of 16-in. line from the Colorado River to Twentynine Palms, California and Section 6 is a 46-mile 16-in. section from Twentynine Palms to Olive, California.

● **G.E.T. Construction, Inc., 435 S. 116th St., Milwaukee, Wisconsin.** Has 46 miles of 24-in. loops in Wisconsin and Illinois for *Michigan Wisconsin Pipe Line Company*.

● **Hunsaker Trucking Contractor Inc., P. O. Box 97, Carrollton, Texas.** Has subcontract for H. B. Zachary Company 134 miles of 12 and 16-in. line between Corsicana and Clyde, Texas. Has stringing contract for 20 miles of 12-in. and 10 miles of 10-in. between Sonora and Eldorado, Texas, for *Pioneer Natural Gas Company*.

● **Potashnick Construction Company, Box 423, Cape Girardeau, Missouri.** Has joint venture with A. P. Vaughn Construction Company to lay sections 1 and 2 of *Four Corners Pipe Line Company* crude line between Utah and California. Both sections are 16-in. pipe; Section 1 is 76 miles from the Aneth field in Utah to Kayenta, Arizona; Section 2 runs 98 miles from Kayenta to Cameron, Arizona. Work on both sections began June 15.

● **Oklahoma Pipe Line Constructors, P. O. Box 13227, Dallas 20, Texas.** Has 35 miles of 30-in. for *Tennessee Gas Transmission Company* between a point in Garrard County, Kentucky, to a point of TGT's compressor site in Powell, Kentucky. Also has 85 miles of 20 and 24-in. (spread 101) of *Trans-Canada Pipe Lines, Ltd.*, on the eastern section, in proximity of Toronto, Ontario, beginning from a point southwest of Toronto circling the city, and also a section beginning at a point east or northeast of Toronto.

● **Brown & Root, Inc., 4100 Clinton Drive, Houston, Texas.** Has contract with *Texas Eastern Transmission Corporation* to furnish field supervision for construction of 626 miles of 30-in. loops along the company's line between Beaumont, Texas, and Uniontown, Pennsylvania.

● **Majestic Contractors Limited, 408 Royal Trust Building, Edmonton, Alberta.** Has an 82-mile 30-in. spread for *Trans-Canada Pipe Lines, Ltd.*, from St. Anne, Manitoba, to the Ontario border. Also has contract for testing 580 miles 34-in. of Trans-Canada line between Burnstall, Saskatchewan and Winnepeg, Manitoba. Has 62 miles of 20-in. line for *Interprovincial Pipeline, Ltd.*, between Sarnia and Port Credit, Ontario. Has contract for 4 to 12-in. gathering system for *Producers Pipeline, Ltd.*, in the Estavan, Saskatchewan area. Has city distribution system in Cooksville, Ontario, for *Consumers Gas Company* of Toronto. Also has city distribution system for Guelph, Ontario, for *Union Gas Company of Canada, Ltd.*

● **A. P. Vaughn Construction Company, Box 1144, Fort Worth, Texas.** Has joint venture with Potashnick Construction Company to lay sections 1 and 2 of the Utah to California crude line for *Four Corners Pipe Line Company*. Both sections are 16-in. pipe. Section 1 is 76 miles from the Aneth field in Utah to Kayenta, Arizona; Section 2 runs 98 miles from Kayenta to Cameron, Arizona. Work began June 15.

● **O. R. Burden Construction Corporation, P. O. Box 5216, Tulsa, Oklahoma.** Has contract for 185 miles of 20-in. crude line for the *Tecumseh Pipe Line Company* to extend from Scherville, Indiana, to Cygnet, Ohio. Has contract for 25 miles of 20-in. in the Bloomfield and Madison townships, Ohio, for the *Ohio Fuel Gas Company-Columbia Gas System*. Has been awarded contract to lay 120 miles of 16-in. and 4 miles of 12-in. crude line for *Magnolia Pipe Line Company* between Abilene and Midland, Texas.

● **Collins Construction Company, P. O. Box 66, Port Lavaca, Texas.** Has 26 miles of 6 to 12-in. to lay offshore for the *CATC Group* from Grand Isle, Louisiana, to a point 26 miles out into the Gulf of Mexico. Marine Gathering Corporation is the prime contractor, and Collins is burying the line being laid by Marine Gathering's pipeline laying barge. Also has 12,000 ft of 24-in. for *Tennessee Gas Transmission Company*, with Pentzien, Inc., the prime contractor; job is three river crossings installed in a downstream catenary across the Mississippi River at Greenville, Mississippi.

● **Latex Construction Company of Georgia, Box 56, Northside Station, Atlanta, Georgia.** Has contract for 93 miles of 14-in. between Lebanon, Indiana, and the south bank of the Kankakee River for *Texas Eastern Transmission Corporation*.

● **Price-Poole Pipeline Constructors of Canada (joint venture of H. C. Price of Canada Limited and Poole Construction Company, Ltd.), Rivers, Manitoba.** Has 99-mile section of 34-in. pipe to lay for *Trans-Canada Pipe Line Company* on a section of line in Manitoba Province extending eastward from the Assiniboine River near Miniota.

● **Williams-Austin Construction Corporation, 3322 Grant Building, Pittsburgh 19, Pennsylvania.** Has 50 miles of 10-in. for *Central Hudson Gas & Electric Company* between Kingston and Albany, New York. Also has 5.7 miles of 26-in. line for Atlantic Seaboard Corporation in Hardy and Grant counties, West Virginia.

● **Holder Construction Company, Box 1438, Snyder, Texas.** Has contract on 134 miles of 6-in. products line for *Trust Pipe Line Company* between Hawley and Wichita Falls, Texas.

● **Panama-Williams Corporation, 1418 Melrose Blvd., Houston, Texas.** Has 85 miles of 12-in. for *Ohio Oil Company* between Robinson and Champaign, Illinois. Also has 177 miles of various size line to lay in South Carolina for the *Carolina Gas Company*.

● **Western Pipe Line, Inc., 1011 San Jacinto, Austin 66, Texas.** Has 94 miles of 30-in. for *Northern Ontario Pipe Line Crown Corporation* between Hawk Lake and Hyndeman, Ontario. Has 55 miles of 14-in. for *Texas Eastern Transmission Corporation*, between Kankakee and Chicago, Illinois.

● **Panama Inc., 1418 Melrose Blvd., Houston, Texas.** Has contract for 362 miles of 16-in. for the *Texas-New Mexico Pipeline Company* from Jal, New Mexico, northwestward. Has 193 miles of 4 to 24-in. line in Mocane and Laverne, Oklahoma, fields for *Colorado Interstate Gas Company*.

● **Four Way Company, Farmington Hwy., Aztec, New Mexico.** Has contract to lay 16-in. line for *Texas-New Mexico Pipeline Company*, for a distance of 150 miles southeast from the Aneth field in Southeast Utah.

● **Lone Star Pipe Line Constructors, Inc., P. O. Box 13167, Dallas 20, Texas.** Has 83 miles of 16-in. for *Permian Basin Pipeline Company* between stations at El Dorado and Midland, Texas.

Don't miss the 1957 Construction Round-Up beginning on page D-21 of this issue.

Pipeline News

Trans Mountain Oil Pipe Line Company will start construction this fall of a large modern oil loading dock at the company's Westridge Marine Terminal on Burrard Inlet, to accommodate the more general use of 60,000-ton class supertankers for lifting Canadian crude oil.

The trend in tanker construction in recent years has been toward tankers in excess of the 16,000 ton T2 class giving considerably lower operating cost. For Alberta crude oil to be available and competitive at off-shore markets, it will be necessary for supertankers to be able to load at the Trans Mountain Marine Terminal.

Artist's conception of proposed new dock with 60,000-ton supertanker moored at dock.

Several design features of the new dock are aimed at reduction of loading time in order that large tankers may turn around between tides for the navigation of the Second Narrows channel. Adequate depth of water will be available at the new dock and through both the First and Second Narrows of Burrard Inlet for 60,000-ton class supertankers. The addition of the new dock will permit more than one tanker to be loaded at one time.

The new facilities are expected to be available for service by April 1958.

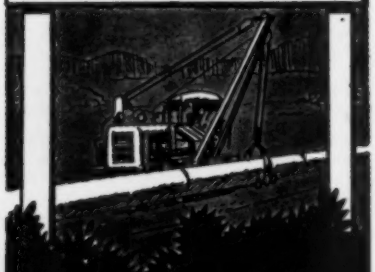
Texaco's new 3-million-gal Lincoln, Nebraska, terminal has been completed and placed into operation, giving The Texas Company greatly expanded distribution facilities in that area. It is located on a 10-acre site adjacent to U. S. Highway 77, near Jamaica, about five miles south of Lincoln.

Begun last August, the Lincoln terminal replaces the company's bulk plant at 1300 North 16th Street and will serve as a wholesale distribution center for Texaco products throughout eastern Nebraska and a portion of northeast Kansas.

In addition to an air conditioned 90-ft by 140-ft masonry warehouse-office building, the facilities include two 1,000,-000-gal storage tanks for automotive gasolines, two 500,000-gal storage tanks for middle distillates, a railroad siding for tank car loadings, and three small tanks for bulk lubricating oils.

The new installation will be supplied through the Great Lakes Pipe Line from Texaco's West Tulsa, Oklahoma, refinery.

O. R. BURDEN Construction CORP.
GENERAL PIPELINE CONSTRUCTION
TULSA, OKLAHOMA



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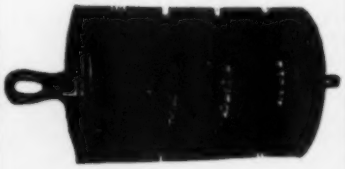

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Pipeline Projects

Texas Eastern and Affiliate File $50,000,000 Program

Applications by Texas Eastern Transmission Corporation, and an affiliate proposing the construction of natural gas pipeline facilities estimated to cost a total of $50,279,100, have been accepted for filing, the Federal Power Commission announces.

Texas Eastern is proposing to build a total of 267 miles of pipeline and 2200 hp in compressor capacity to increase its system capacity by 100,000,000 cu ft per day to supply additional gas to 13 existing customers. The affiliate, Texas Eastern Penn-Jersey Transmission Corporation, also of Shreveport, proposes to construct 65½ miles of loop line and 4000 hp in compressor capacity to increase its system capacity by about 60,000,000 cu ft per day. These facilities would be leased to Texas Eastern for operation.

Texas Eastern's proposed project includes 22 miles of 14-in. supply line in Louisiana, 105 miles of 30-in. pipe paralleling sections of its existing system between Opelousas, Louisiana, and Kosciusko, Mississippi, and 140 miles of 30-in. line paralleling sections of its system between Kosciusko and Uniontown, Pennsylvania. The 2200 hp would be installed at a new compressor station in Westmoreland County, mated cost of these facilities is $38,908,100.

Penn-Jersey plans to install an additional 4000 hp at its Delmont compressor station in Westmoreland County, Pennsylvania, and to build 65½ miles of pipeline along its existing system between Delmont, Pennsylvania, and Lambertville, New Jersey.

In connection with Texas Eastern's application, four independent producers have asked for authority to sell a total of approximately 100,000,000 cu ft of gas per day to the pipeline company from their properties in the Rayne Field, Acadia Parish, Louisiana. The producers are Continental Oil Company, of Houston, Texas, M. H. Marr, of Dallas, Texas; Sun Oil Company, of Philadelphia, Pennsylvania, and General Crude Oil Company, of Houston. These matters have been consolidated with the others as bearing upon the subject of economic and financial feasibility of the whole.

Cities Service to Develop Elk City Storage First

Cities Service Gas Company, Oklahoma City, Oklahoma, has been given temporary authority by FPC to develop the Elk City storage field in Montgomery County, Kansas.

Cities Service originally filed an application proposing to develop the Vilas storage field in Wilson and Neosho counties, Kansas. In a supplement to its application, Cities Service proposed to acquire and operate either the Elk City field or the Vilas field as a storage field in 1957. Cities Service was willing to develop either of the fields in 1957 and defer action on the other field until 1959 or 1960, but also stated that it was having considerable difficulty in obtaining storage leases in the Vilas field because of excessive costs.

The company said that either of the two storage fields would accomplish virtually the same result, supplying approximately 50,000,000 cu ft on the peak day in 1958-59 and 100,000,000 cu ft on the 1959-60 peak day. The applicant later elected to acquire and operate the Elk City field first. The estimated total cost of the Elk City field is about $2,683,073. Additional facilities are for the primary purpose of meeting increased peak day requirements of existing customers.

PNW to Construct Lateral to System

The Federal Power Commission has authorized Pacific Northwest Pipeline Corporation to construct and operate 36.9 miles of 8⅝-in. lateral line from its 20-in. Spokane lateral to the plant of Utah-Idaho Sugar Company near Moses Lake, Washington, and two measuring and regulating stations to serve the plant and the City of Moses Lake.

The applicant had been authorized to serve Moses Lake from its Wenatchee lateral, but subsequent studies indicated that the Spokane lateral would be closer.

New York State Natural to Build Station, Lay Line

The Federal Power Commission has granted a temporary certificate to New York State Natural Gas Corporation to build a 3000-hp compressor station near Utica, New York, and 9 miles of 12-in. branch line extending from an existing line to Oneida, New York, with a measuring and regulating station at Oneida, to make deliveries to Niagara Mohawk Power Corporation. New York State Natural also will construct a measuring and regulating station at East Greenbush, New York.

$33,737,000 Expenditure On Gulf Interstate Calendar

Gulf Interstate Gas Company proposes to add 69,000 hp in 10 main line compressor stations in Kentucky, Tennessee, Mississippi, and Louisiana; to construct a 300-hp compressor station at East Mud Lake field, Cameron Parish, Louisiana, and lay approximately 10 miles of loop supply pipeline from Erath field. Estimated cost of these facilities is about $24,500,000.

The company also proposes to construct about 8.7 miles of various diameter field lines in Acadia and Vermilion parishes, Louisiana, at an estimated cost of approximately $272,000.

The proposed construction is for the purpose of increasing designed capacity of its existing facilities by 127,000,000 cu ft of natural gas per day.

This application is pending before the Federal Power Commission.

FPC has granted a permanent certificate to the company for compressor facilities totaling 19,500 hp in Louisiana, Mississippi, Tennessee, and Kentucky, and miscellaneous small gathering lines and measuring stations. Temporary authority for this work was granted some time ago. Cost of these facilities is estimated at $8,965,000.

Mexico to Florida Line Via Cuba is Talked

The Cuban Gas Transmission Company has been organized by a group of American and Cuban businessmen for the ambitious purpose of laying a gas pipeline from Mexico to Florida by way of Cuba.

The project originated with Edwin Pauley, Los Angeles oilman. It embraces a pipeline extending 500 miles overland from Campeche to Cape Catoche, Mexico, then under the Yucatan Canal to Cape San Antonio, Cuba, 150 miles overland from there to Havana, and under the Florida Strait to Florida.

Overall, the pipeline would be approximately 1000 miles in length, with about one-fourth of it underwater.

Participants in the venture, in addition to Pauley, are Frederick Anderson of Palo Alto, California; Donald Royce of Los Angeles; John Ohl and Arnold Daun of New York; Oscar Gans, Norberto Otero, and Eduardo Grenas, all of Havana, Cuba.

The 1957 Construction Round-Up Begins on D-21.

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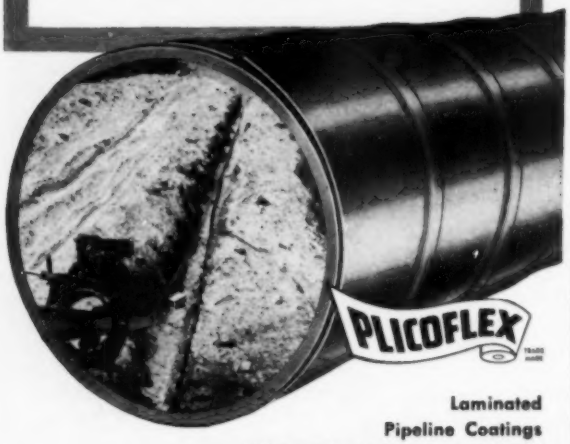

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Projects

Transco Plans New Lines Into South Louisiana Fields

Transcontinental Gas Pipe Line Corporation has filed application with the Federal Power Commission for a certificate to add to its reserves new purchases of natural gas recently contracted for in seven Louisiana fields near New Orleans.

In Houston, Transco President E. Clyde McGraw said that the new supplies of natural gas will be added to the company's system as soon as a certificate is received and construction completed on the proposed facilities.

The new contracts provide for a minimum purchase of 68,000,000 cu ft of gas daily during the first year; however, capacity of the supply system to be constructed will be 222,000,000 cu ft a day. Substantial undeveloped reserves exist in the area and anticipated additional volumes of natural gas dictate the extra line capacity. The supply system which Transco proposes to construct will cost slightly more than $14,000,000.

McGraw said that 65 miles of 24-in. lateral will extend almost due south to the Mississippi River from a point of connection with Transco's main line in St. Helena Parish on the Louisiana-Mississippi state border. The 24-in. line will span St. Helena, Livingston, Ascension, and St. James parishes. A multiple crossing will be built under the Mississippi River near the town of Convent.

South of the Mississippi River, 22 miles of additional 24-in. lateral is planned. Smaller laterals, 10 in. and 6 in. in diam, will extend into the seven fields. Construction is planned to start in early 1958.

Gas fields containing reserves under contract to Transco in the parishes of Lafourche and St. Charles are North Thibodaux, Thibodaux, Raceland, Bayou des Allemands, Lucy, Lac des Allemands, and Hahnville. A total of nine purchase meter stations will be built by Transco at these fields.

Building Three New Pump Stations, Adding to Others

Three new pump stations are being constructed in Missouri and Illinois by Service Pipe Line Company to increase capacity of the company's crude oil pipeline system to Chicago and Michigan refineries.

Plans have been made to install a 2000-hp electric-centrifugal pumping unit at Medill station near Medill, Missouri. A 2500-hp unit will be installed at Ormonde station near Ormonde, Illinois, and another at Streator station near Streator, Illinois.

Additional horsepower will be added at four other stations in the Missouri-Illinois division of Service. At Freeman, Missouri, a 1000-hp unit will be added. At Mayview and Rothville stations, between Kansas City and La Plata, a 2000-hp unit will be installed at each station to supplement the units now in use. At Manhattan, Illinois, an additional 2000-hp unit will be installed and a 1500-hp unit will replace a 1000-hp unit.

The new pumping units will increase average winter capacity between Freeman and La Plata, Missouri, by 29,000 bbl per day. The system is currently moving some 260,000 bbl daily. Average winter capacity between La Plata and Manhattan, Illinois, will be increased by 40,000 bbl per day. It is currently moving about 193,000 bbl.

Service also is planning to construct 4.2 miles of 12-in. line between its Manhattan to Whiting line and Buckeye Pipe Line Company at Griffith, Indiana. Service also will add 7.5 miles of 24-in. line in the Manhattan to Whiting section of the system.

The unsettled Middle East situation has caused major oil companies to order more tankers. Many are supertankers that can by-pass the Suez Canal and go around Africa. Esso Standard has ordered 10 tankers for its German affiliate. These average 43,000 tons each. Socony Mobil has ordered five tankers averaging 48,600 tons.

Japanese and European shipbuilders are getting most of the tanker business because of the high costs of United States yards. U. S. yards can make quicker deliveries, however.

Federal Power Commission has denied a rehearing of its June 24 order authorizing large offshore natural gas sales in the Gulf of Mexico by four independent producers, known as the CATCO group, to Tennessee Gas Transmission Company.

Rehearing was requested by Public Service Electric and Gas Company, The Long Island Lighting Company, and Lake Shore Pipe Line Company, all customers of Tennessee, and the New York Public Service Commission.

The FPC's June 24 order authorized the sales to Tennessee without any condition regarding the initial price of the gas, as had been the case in an early order granting certificates to the four producers. In taking that action, FPC said that the natural gas rates of three of the producers, Continental Oil Company, Tidewater Oil Company, and Atlantic Refining Company, already were under investigation, and it concurrently issued an order instituting an investigation of the rates of the fourth producer, Cities Service Production Company.

In denying rehearing, FPC said the applications "set forth no new facts and no principles of law which either were not fully considered by the commission when it issued that order or which having now been considered warrant any change in or modification of such order."

A bulletin designed to unify methods and practices employed to measure evaporation losses from tanks and transportation equipment is being published by the American Petroleum Institute.

Known as API Bulletin 2512, its title is "Tentative Methods of Measuring Evaporation Loss from Petroleum Tanks and Transportation Equipment." It was prepared by the Institute's Evaporation Loss Committee, under the chairmanship of J. H. McClintock, of Esso Standard Oil Company, New York.

McClintock said Part I of the bulletin discusses the basic procedures in measuring evaporation losses, and offers general guidance for selecting methods for the determination of losses from tanks and transportation equipment under specific conditions of service.

Part II provides detailed descriptions of eight methods, the chairman said. Copies of the bulletin, one of several which the Evaporation Loss Committee plans to do, may be obtained from the Institute at $2 each.

Extensive interior renovation of the Walton N. Moore Building, at Mission and Fremont streets, San Francisco, will be made for Pacific Gas and Electric Company by the Dinwiddie Construction Company.

The eight-story building was purchased several months ago by PG&E as an annex to its general office building at Market and Beale streets, two blocks away. A substantial portion of the 177,000 sq ft is now unfinished loft space. Much of this will be used to house electronic data processing equipment to be used in accounting and engineering work.

Alterations will be completed in two phases. The first phase will be completed by November and the balance by March, 1958. Modern elevators, air conditioning, and extensive new lighting will be installed.

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Compact Pyrometer. A new line of small millivoltmeter pyrometers, the HP-30 series, has been announced by General Electric's Instrument Department. Designed to keep pace with the trend to smaller size in process instrumentation, pyrometer employs a new high-strength magnet material, printed circuits, and miniature tubes.

Used primarily for temperature control, the pyrometers can also be used to measure other process variables such as speed, vacuum, density, and electrical quantities. HP-30 pyrometers have application in any industrial processes requiring heat, including equipment manufacturers and producers in foundry and other heat treating operations, drying processes, plastic molding and extrusion, rubber fabrication systems, and government test facilities. *General Electric Company.*

Circle number (81) on reply card.

Control for Variable Speeds. Variable speed, for control of both quantity and quality of machine output, is used in many operations. Manually controlled variable speeds usually requires one or more men and constant supervision.

By controlling speed with the Varitrol as a component of the U.S. Varidrive motor, speeds can be automatically changed in response to a signal without human attention for precision-control operations. Any process requiring automatic variable speeds can be driven by the U.S. Varidrive with Varitrol control. Ratings ¼ to 60 hp. *U.S. Electrical Motors, Inc.*

Circle number (82) on reply card.

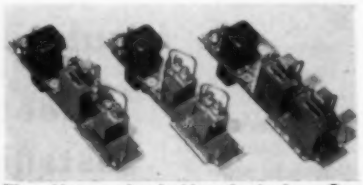
Range Change with Plug-in Clips. Replaceable plug-in range clips for quick range changing is one of the many features which distinguish the Weston Model 6705 strip chart Multiple Point Recorder.

Like other instruments in the series, unit operates on the null balance principle, and all components are likewise grouped in the simplest, most efficient, most serviceable manner. In addition to plug-in range clips it also features easily changed chart speeds, and a simplified method of changing printing speeds which makes it readily adaptable to a wide variety of applications. *Weston Electrical Instrument Corporation.*

Circle number (83) on reply card.

Clears Dispatcher's Desk. Complete new concept in mobile communications equipment combines base station microphone controls and speaker into a single, compact unit. Designed to provide maximum mounting flexibility and operational versatility, controls include a microphone, loudspeaker, 2-frequency transmitter switch, and a continuously variable volume control. Two-frequency receiver switch and a squelch control are included for local control operation. *Radio Corporation of America.*

Circle number (84) on reply card.



The Hammarlund Manufacturing Co., Inc.'s COC units used in remote telemetering and control operations. From left to right: DSU-12 (audio-tone transmitter and receiver); DTU-12 (audio-tone, 2 transmitters); DRU-12 (2 audio-tone receivers). Each unit is complete in itself with self-contained power supply. Any one may be operated completely independent of other units. All COC equipment pieces are made up in modular, plug-in form so field maintenance may be done by non-technical personnel.

Circle number (85) on reply card.

Electrolytic Conductivity. Instrument was developed especially for recording electrolytic-conductivity at remote locations where electrical power is not available. Chart drive is a clockwork mechanism and electronic portions have been transistorized to minimize battery drain. Instrument uses an ac Wheatstone Bridge self-balancing principle with a bridge frequency of 1000 cps. Measurements of electrolytes ranging from distilled or demineralized water to strong acids can be made. *Industrial Instruments Inc.*

Circle number (86) on reply card.

Gage Needs No Power. Remote reading senior liquidometer provides dependable and completely automatic readings of tank levels without the aid of any outside source of power. A large easy to read dial can be calibrated in gallons or any other unit of measurement. Weatherproof cases can be furnished for outdoor installations. Ideally suited to applications where electric current or compressed air is not available, indicators can be installed as far as 250 ft from the tank. *The Liquidometer Corporation.*

Circle number (87) on reply card.

Tubeless Voltage Regulator. Stabiline Automatic Voltage Regulator Type TM7101 maintains constant output regardless of line voltage or load fluctuations. It has no tubes, transistors or moving parts. It is ideally suited for applications where little or no attention is possible such as microwave relay stations and remote installations. Unit has a rating of 1 kva. *The Superior Electric Company.*

Circle number (88) on reply card.

Vibration Measures Pressure. A vibrating tungsten wire is the measuring element in the new BJ Vitrotron digital gage. A miniature electronic transducer, it is capable of precise measurement of such variables as acceleration, pressure, displacement, temperature, etc. Principle of operation is simple, pressure or other forces act on the wire to change its natural frequency of vibration which is in turn projected as electrical impulses. These frequency pulses are readily handled by digital meters, systems and computers.

Catalogs and additional data are available upon request. *BJ Electronics, Borg-Warner Corporation.*

Circle number (89) on reply card.

Cable Tape. Okoweld is designed for splicing and terminating either plastic or rubber cables. For connections operating under 2000 volts it serves as both insulation and sheath. "Two-tapes-in-one" feature is possible because Okoweld, while possessing optimum electrical characteristics, is also resistant to weather, chemicals, flames and mechanical abuse. *The Okonite Company.*

Circle number (90) on reply card.

Integrating Flow Meter. The Librascope Flow Computer is a newly developed instrument that simplifies computations in the orifice measurement of fluids. It embodies the principle of pressure compensated double integration. The Computer extracts the square root and continuously integrates both differential and static pressures, without the use of cams or other intermittent devices. Responses are rapid, since both the static and differential pressure inputs are directly connected to the sensing elements. No electrical or pneumatic relay systems are required. *Librascope.*

Circle number (91) on reply card.

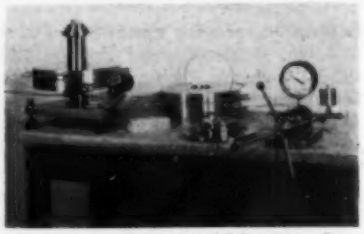
Sensitive Relays. New electronic component, designed to resist vibration, corrosion and shock, hosts an array of standard features which include a 2 pole, double throw plug-in relay protected by a clear polystyrene dust-proof cover; a long life plug-in transistor amplifier and power pack module; 12 volt d-c sensing circuit and a low sensing circuit current. Long distance remote control, liquid level control and photo cell applications are also possible due to the relay's sensitivity. Rated up to 19 amp, 110 v, 60 cycles, the relay is available in an open type panel or NEMA type 1 bonderized general purpose enclosure. *Cutler-Hammer, Inc.*

Circle number (92) on reply card.

Mobile O_2 Analyzer and Recorder. Leeds & Northrup announces a mobile analyzer and recorder for flue gas and other O_2 dependent processes. Assembly uses magnetic O_2 analyzer and Speedomax recorder, and can be quickly wheeled from one test point to another. It gives fast, accurate O_2 measurements. *Leeds & Northrup Company.*

Circle number (93) on reply card.

Dead Weight Gage. The Ruska dead weight gage, or absolute pressure gage, is a laboratory standard for precise pressure measurements. Extreme care is taken in its manufacture, as well as calibration, to produce a pressure measuring instrument of the first order. It can be furnished for



two pressure ranges: A high range, from 30 to 12,140 psi; and a low range, from 6 to 2417 psi. Reproducibility is 0.01 percent at one-twentieth or more of load capacity. *Ruska Instrument Corporation.*

Circle number (94) on reply card.

Transistors Lower Telemeter Cost. New type of tone telemeter designated Tone-Link, has been in operation in the New England area for over a year. Field tests of this 100 percent transistor 18 channel system indicate greatly reduced operational and maintenance costs over competitive vacuum-tube equipment. Excellent noise, harmonic, and intermodulation rejection, are features of this Type TT1 telemeter.

Presently used in pumping stations for monitoring and controlling temperature, pressure, flow, level, and valve position, the system has wide control and metering application in chemical processing, petroleum, and electric utility fields. *Warren Manufacturing Company, Inc.*

Circle number (95) on reply card.

Measure Force, Pressure . . . Size, motion, force, pressure, flow, stress, strain and other physical quantities can be measured digitally. Action is completely null balance in character, using only 1 simple moving part, and is not affected by changes in tube characteristics, line voltage, etc. Three digit output information is displayed on the front panel.

The Model 600 is designed for use with Daytronic, Schaevitz, and similar differential transformer transducers with full scale span adjustable over ranges of core movement from .010 to .100 in. The Model 601 is designed for use with conventional strain gage transducers using 1, 2, or 4 gages. *Daytronic Corporation.*

Circle number (96) on reply card.

Pressure Pickup Performs at 5000 F and Over. Norwood Controls announces a new high-temperature pressure transducer designed for use in rocket and jet engines, high temperature chemical reactions and other high pressure, high temperature applications. The transducer uses the same catenary diaphragm and tubular strain gage as Norwood's highly successful air-cooled pressure pickups and an efficient water-cooling system enables the diaphragm to withstand gas temperatures above 5000 F.

Frequency response is extremely high and is flat to 10,000 cps. Models are immediately available for 0-1000 and 0-2000 psi ranges with 1 percent of full scale accuracy and excellent temperature compensation. *Norwood Controls, Unit of Detroit Controls Div. of American Standard.*

Circle number (97) on reply card.

Glass Fabric Pipeline Joint Wrap. Stronger glass fabric-base pipeline joint wrap, known as Duratape, features increased tensile strength in both longitudinal and horizontal directions.

Consisting of a woven glass fabric base, heavily coated on each side with either a coal tar or asphalt covering product boasts a tensile strength of 120 lb per lineal in. for the width dimension. This is an increase of 20 times its former rating. *L-O-F Glass Fibers Company.*

Circle number (98) on reply card.

Handling Bar Unloads Pipe Sections. Job of unloading and stacking long pipe lengths is efficiently done with a unique handling bar mounted on the forks of a Hyster 60. Pipe sections are held at either end of the bar by a hook and cable.

Truck loading is easier because the pipe sections do not have to be separated by spacers. Bar attachment is easily demounted from the forks, enabling the truck to perform other handling jobs. *Hyster Company.*

Circle number (99) on reply card.

Hydraulic Valve Control. Designed for use with air, gas, oil or water at pressures up to 200 psi is a new line of medium duty plug valve operators. These valve operators are adaptable to a wide range of control requirements, including process cycling, safety and automatic shut-offs, or any combination of these requirements.

The Model FM is for use on valves requiring relatively low torques. It is a floating bar type operator incorporating 2 single acting cylinders. The Model TM is designed for valves requiring higher torques. This operator utilizes 2 double acting cylinders. *Ledeen Mfg. Co.*

Circle number (100) on reply card.

Transistor Tone Telemeter. A new type of transistor tone telemeter is in operation for centralized monitoring and control of temperature, pressure, flow, level and valve position at remote locations in many applications.

Field tests reveal a high degree of reliability with transistor circuits. Sharply notched bandpass filtering permits allocation of tone channels 120 cycles apart. Tone signals may be applied simultaneously as a composite signal to any private open wire, cable, radio or microwave system, hence multiplying telemetering circuits.

Through 3 stages of transistor amplification, tones are made to operate directly individual power control relays associated with each receiver. *Warren Manufacturing Company, Inc.*

Circle number (101) on reply card.

Transistorized Audio-Tone Transmission. Centralized supervisory control systems can now utilize the many distinct advantages of transistorized audio-tone transmission. This type of transmission has proved ideal for telemetering such quantities as pressure, temperature, level, flow, turbidity, chlorine residual, pH, conductivity, and many others.

Ease of assembly interchangeability, installation, and system expansion are features of the compact, completely transistorized, "plug-in" design of the power supply, transmitters, and receivers. The 100 percent transistor circuits eliminate costly tube power consumption and maintenance. Specially developed circuit design eliminates frequency interference on adjacent channels. *Builders-Providence, Inc.*

Circle number (102) on reply card.

New 125 CFM Rotary Compressor. Known as the Davey Hydrovane Rotary 125, unit is said to be the only multi-stage rotary compressor with a single free-floating rotor. So located that it is constantly concentric with 1 side only of the stator, its blades are of the segmented type, inserted radially in longitudinal slots. Units are available in 2-wheel trailer and skid mountings. *Davey Compressor Co.*

Circle number (103) on reply card.

Quick Coupling. A coupling that can be assembled and disassembled in seconds has been developed for high impact polyvinyl chloride pipe. New coupling is recommended for temporary chemical, oil, water or disposal lines. To couple, grooved end of the pipe is pushed into the coupling until the thrust ring seats in the groove. To disassemble, disassembly tool is placed and the pipe is simply pulled out of the coupling. Quick coupling Koroseal rigid pipe is available in 2-in., 3-in. and 4-in. sizes in standard 20- and 30-ft lengths. *B. F. Goodrich Industrial Products Company.*

Circle number (104) on reply card.

Engine-Generator Set. Compact Caterpillar D318 (Series G) engine is now available as the power unit for both turbo-charged and naturally aspirated electric sets. Electric sets combine Cat D318 engine, with the space-saving and self-regulated constant voltage Cat generator, to produce a compact unit for power generation. The turbo-charged electric set arrangement is rated at 75 kw, and the naturally aspirated at 60 kw. *Caterpillar Tractor Company.*

Circle number (105) on reply card.

Flexible Shaft With Equal Torque. A new flexible shaft with equal torque in both directions, unlimited length and equal flexibility in all sizes from ⅜ to 3 in. diameters is designed for remote controls and power drives. Links consist of trunnion blocks and 2 half links fastened together with screws or rivets. Cover materials are available in a variety of materials including armored neoprene hose, non-metallic hose or semi-rigid tube.

Manual torsional movement ratings are 50 in. lb for ⅜-in. shaft, to 2500 in. lb for 1¼-in. shaft. *Clark Flexible Link Shaft Company.*

Circle number (106) on reply card.

Out-of-Round Attachment. H & M Pipe Cutting and Beveling Machine Company has announced a new "out-of-round" attachment for standard pipe cutting and beveling machines. Working on the spring-tension principle, the spring and a roller

rod assembly are the 2 main components of the attachment. The special attachment is engineered to eliminate the problem of inaccurate cuts or bevels on "out-of-round," or imperfect pipe. *H & M Pipe Cutting and Beveling Machine Company.*

Circle number (107) on reply card.

NEW Literature

For more information on items described here in brief, use the handy reply card and circle the corresponding numbers

Manual Motor Starters. Eight-page publication covers new small-size General Electric "100 Line" manual starters for fractional-and integral-horsepower motors up to 7½ hp. Two-color bulletin includes new features, application and installation data, and a rating table for the new plug-in heaters. It illustrates all available open and enclosed forms with dimensions for each. *General Electric Company.*
Circle number (108) on reply card.

Catalog and Engineering Manual. Aetna Ball & Roller Bearing Company issued the 15th edition of its General Catalog and Engineering Manual. The 88-page book includes an 18-page engineering data section on terminology; how to select ball thrust bearings; how to calculate thrust load capacities for any speed; how parallelism and flatness affect thrust bearing performance; fits and tolerances; formulas for calculating thrust loads for various gear drives; oil and grease lubrication methods; a grease selection guide; and how to handle and care for bearings. A section is included on Aetna's new line of sealed, pre-lubricated ball bearing "package" units. *Aetna Ball & Roller Bearing Company.*
Circle number (109) on reply card.

Concrete Tanks. New 8-page technical bulletin, T-19, on the Design of Prestressed Concrete Tanks, gives engineering data and formulae of general interest to anyone considering prestressed concrete for storage tanks. *The Preload Company, Inc.*
Circle number (110) on reply card.

Bulldozer Comparison. Charts comparing features and performance of Case Terra-Trac 80 and 100 hp bulldozers with competitive makes, are contained in a new bulletin, CTS-105. Eight pages of photographs and operational drawings show how "Tilt-Crown" bulldozers can be tipped and tilted hydraulically from operators seat for ditching, road-crowning, grubbing, ripping hard ground, etc. Advantages of torque converter drive and counter-rotating hydraulic transmission are also shown. *J. I. Case Company.*
Circle number (111) on reply card.

Step-by-Step Maintenance for Floors. New comprehensive bulletin on the maintenance of Terrazzo and Oxychloride floors has been published by Multi-Clean Products, Inc. Method described in this bulletin is a complete scientific floor care program for both old and new floors. *Multi-Clean Products, Inc.*
Circle number (112) on reply card.

Reinforced Plastic Tubing. New type of reinforced plastic PVC tubing that has been flexed to an angle of 90 deg over 1½-million times without cracking or breaking and that will bend around a 5/16 in. diameter spindle without its internal bore being reduced is described in a 2-color leaflet. Versatile tubing is weatherproof and resistant to gasoline, oils, high octane fuels and sea water and will serve thousands of uses because it is light in weight. Specifications list a working temperature ranging from 170 F to −5 F, working pressures of 100 to 200 lb and sizes from ⅛ in. to 1 in. *Newage Industries, Inc.*
Circle number (113) on reply card.

Complete Handbook on Liquid Handling. Wheaton Catalog No. 65 is a 100-page brochure covering loading arm assemblies, loading valves, swing joints, truck tank equipment, storage tank fittings and miscellaneous products for the efficient handling of bulk liquids. It contains full specifications, diagrammatic views and recommended applications on all standard products. One complete section is devoted to engineering data. *Wheaton Brass Works.*
Circle number (114) on reply card.

A Fact-Packed Valve Booklet. Bulletin HB-6 describes Conoflow's complete line of air-operated Saunders valves, available in all sizes, for both on-off and throttling control. Booklet explains operation and application of the Saunders patent-type valve body, shows exclusive auxiliary features such as the Airlock and Bonnet Loading and includes valuable sizing data and a comprehensive listing of flow coefficients to aid you. *Conoflow Corp.*
Circle number (115) on reply card

Self-Cleaning Strainers. Golden-Anderson self-cleaning liquid strainers are described in a new bulletin. The Banks Continuous Strainer, is especially designed for the straining of fluids without interrupting the flow for cleaning the screen. Since the screen is constantly kept clean, small perforations of .023-in. diameter are used, which effectively stop the smallest of troublesome particles. *Golden-Anderson Valve Specialty Company.*
Circle number (116) on reply card.

Revised Welding Catalog. Revised to include data on the new Ampco-Trode 46 electrode and new Ampco Braz No. 1, No. 2 and No. 3 filler rods, Bulletin W-17 contains up-to-date technical information relative to arc welding with bronze electrodes, filler rod and wire. Described in the 24-page catalog are welding procedures, techniques and processes, recommended welding currents, typical applications, and a comprehensive electrode and filler rod selection and pre-heat chart. *Ampco Metal, Inc.*
Circle number (117) on reply card.

"Pipelining." The complete line of pipeline equipment manufactured by Caterpillar Tractor Co. is detailed in a 2-color brochure. The brochure deals with the company's line of pipelayers, including the No. 583, No. 572, MD6, MD7, and hydraulic pipelaying attachments for the D4 and D2 tractors. In addition, the use of Caterpillar diesel engines as power units for such pipeline equipment as ditchers and arc-welders is also explained. *Caterpillar Tractor Co.*
Circle number (118) on reply card.

Plug Valve Actuators. Ledeen plug valve actuators are of simple and rugged construction, have no rotating motors, gears, bearings, clutches or other fast-moving parts. They will not "freeze" or burn out, cannot be overloaded, and require negligible maintenance. All these features are discussed in Bulletin 3040. *Ledeen, Inc.*
Circle number (119) on reply card.

Tested Points. Four ESCO tested points can be changed in 4 minutes. These points reduce cost per yard. Besides data on these points, Bulletin 187-C also gives specifications on shovel dippers and draglines, front end loaders, rippers and clamshells. *ESCO Limited.*
Circle number (120) on reply card.

Engineering Data Sheet. The Milton Roy Company released a new application engineering data sheet, D-57-1. This 4-page data sheet describes several methods of combating corrosion and delignification in cooling towers, using controlled volume pumps to meter precise quantities of chemicals to cooling water. This data sheet features complete details and drawings explaining continuous pH control, acid metered in proportion to flow rate, chemical feed with automatic level control and other low-cost cooling tower water treating systems. *Milton Roy Co.*
Circle number (55) on reply card.

Brochure Describes Services. A new 2-color, 12-page brochure describes the products, capabilities, and facilities of the new Magnetics Division of Servomechanisms, Inc. Detailed information is provided on the facility which designs and manufactures custom magnetic components such as transformers, magnetic amplifiers, filters, converters, reactors, discriminators, and networks. *Servomechanisms, Inc., Magnetics Division.*
Circle number (56) on reply card.

Magnetic Motor Starters. New 20-page publication contains comprehensive data on General Electric's radically new NEMA Size 0 and 1 magnetic motor starters for such applications as machine tools, pumps, hoists, blowers, saws, fans, mixers, compressors, and motor control center. Illustrated bulletin shows how product's design contributes to fast installation, simplified wiring, easy inspection and maintenance, long life, quiet and dependable operation, and maximum flexibility. *General Electric Company.*
Circle number (57) on reply card.

Bending Pipe, Tubing. Engineers, designers and others involved in the fabrication of pipe and tubing will find Bulletin TDC-187 useful. This 6-page folder describes the various methods of bending pipe and tubing and supplies helpful hints which will overcome many of the fabricator's bending problems. *Tubular Products Div., The Babcock & Wilcox Company.*
Circle number (58) on reply card.

Meters and Controls. Instruments introduced within the last year have been included in new 8-page, 1957 edition of Bailey Meter Company's annual Bulletin G15-1. Applications, ranges and detailed literature references are given for complete line of Bailey transmitting, recording, indicating, and controlling instruments. *Bailey Meter Company.*
Circle number (59) on reply card

Right Truck For The Job. The right truck and attachment for practically every mechanical handling application is covered in a 12-page condensed guide of industrial trucks and attachments prepared by Hyster Company. The book covers Hyster's complete line of basic truck models. The lift truck line includes cushion-tired space saver models from 3000 to 5000 lb capacity and pneumatic-tired units from 1000 to 20,000 lb capacity.

Working specifications for each truck shown in the catalog include: Load capacity, stacking aisle and turning radius, tire size, grade climbing ability, engine horsepower, lifting and travel speed, truck weight and optional equipment. *Hyster Company.*
Circle number (60) on reply card

The Petroleum Engineer's

RIG LOCATOR

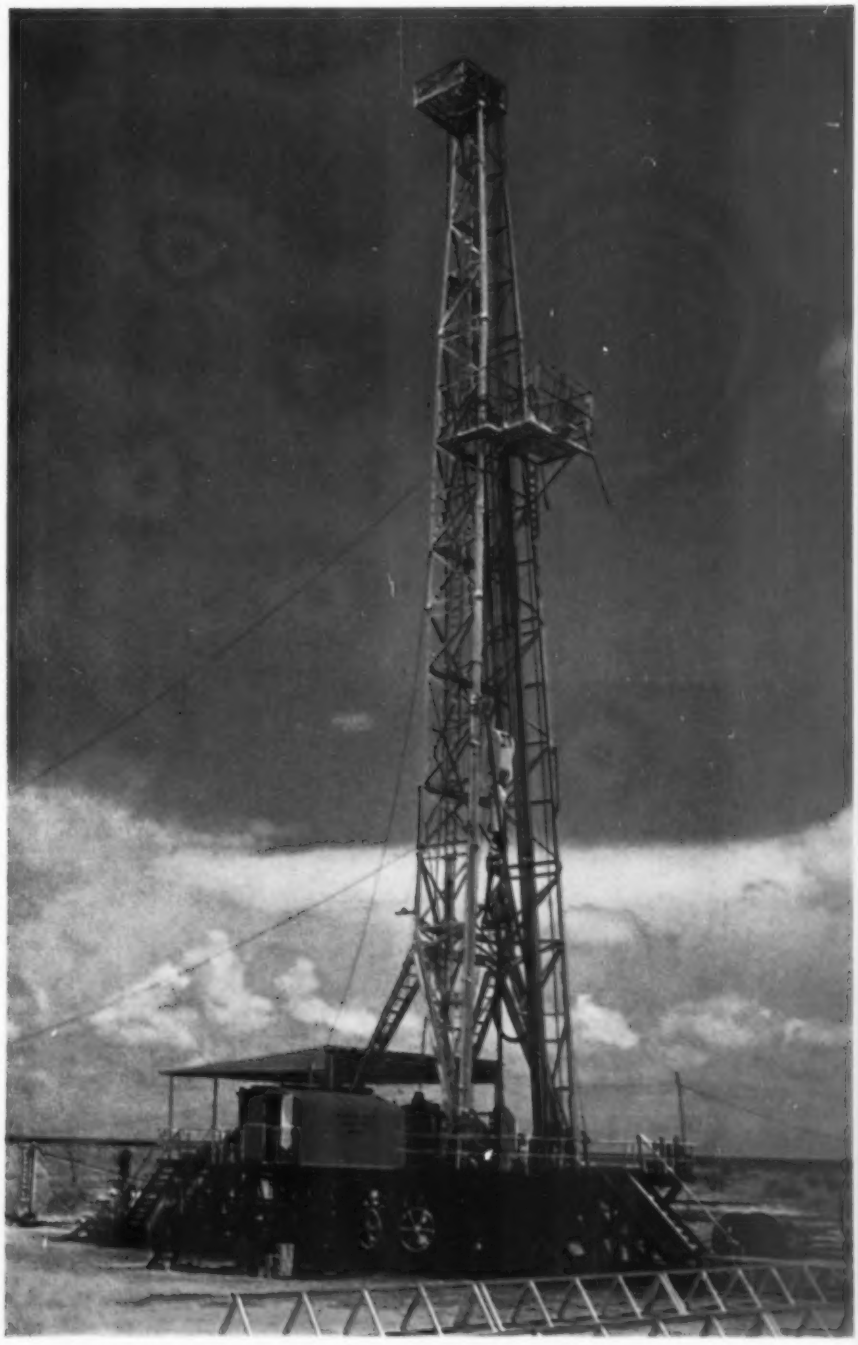
Exclusive directory of U. S. and Canadian Contract Rigs

Name and address of over 800 leading rotary and cable tool contractors, showing current location and pertinent rig specifications of nearly 3000 drilling rigs.

- ***U. S. Rotary Rigs***
- ***Canadian Rotary Rigs***
- ***U. S. Cable Tool Rigs***
- ***Canadian Cable Tool Rigs***
- ***Foreign Contract Rigs***
- ***Special Offshore Rig Locator***

The industry's only comprehensive directory of its kind . . . celebrating its second anniversary of publication . . . as a service to the contract drilling industry . . . and to the producer searching for a certain rig in a specific area. Another first for The Petroleum Engineer, pioneer of engineering and operating information that helps the industry do a better job.

P. O. Box 1589, Dallas 21, Texas



. . . courtesy Tri-Service Drilling Co., Midland, and Newsfoto Publishing Co., San Angelo, Texas

Second Anniversary **Fall 1957**

DRILLING RIG LOCATOR

This second anniversary directory lists nearly 3000 rigs owned and operated by over 800 drilling contractors in the U.S. and Canada. Included is a special section on offshore operations.

Here's what it contains:

- **Contractor's name and address**
- **Rig number or name**
- **Type power and fuel**
- **Total hp on main mud pumps**
- **Drawworks make and model**
- **Hp available to drawworks**
- **Rated drilling depth**
- **Current location**

This is the seventh edition of THE PETROLEUM ENGINEER's exclusive and original RIG LOCATOR of U.S. and Canadian drilling contractors, now celebrating its second anniversary of publication. Since the first comprehensive directory was published October 1955, it has continued to grow in usefulness and in content. In this issue, over 800 drilling contractors operating in the U.S. and Canada (as well as some foreign operations) list nearly 3000 rotary and cable tool rigs.

Its primary purpose is to provide sufficient information about each contract rig for evaluation purposes when an operator needs a certain type rig to drill a well in a specific area. This was the original purpose of the first RIG LOCATOR, and it has been responsible for the continued growth of this original directory idea pioneered by THE PETROLEUM ENGINEER. The number of contractors and rigs listed has continued to increase with each publication, and this is the largest RIG LOCATOR ever published to date.

This directory service is offered the industry at no expense to the contractor listing his rigs. It has been gratifying to learn that a considerable number of drilling contracts had their beginning when an operator located the rig he needed and where he needed it from the pages of the RIG LOCATOR. It is the hope of the publishers that this editorial feature will continue to grow in size and in utility to the oil industry.

Editor's Note: The editorial staff of THE PETROLEUM ENGINEER is extremely grateful to the more than 800 drilling contractors who sent in their rig data for this directory. We sincerely hope this information proves of value to them. **To those contractors whose rigs are not listed, and who want their equipment shown in the RIG LOCATOR to be published next March, just send a post card or letter to:**

The RIG LOCATOR Editor,
P. O. Box 1589,
Dallas 21, Texas.

This directory is a free service of THE PETROLEUM ENGINEER for the benefit of the operator and drilling contractor alike.

Special Offshore Rig Locator. The Summer RIG LOCATOR published last July contained for the first time a special section listing drilling operations in the offshore waters of the Gulf of Mexico and off the coast of California. Although most of the drilling is being done by contractors, there are a considerable number of offshore rigs owned and operated by offshore operators.

Because of the high interest in offshore drilling activities, a special section was devoted to identifying and locating all U.S. offshore drilling rigs. Not only does this section include all the pertinent rig specifications listed for land rigs, but other useful information as well. Location designations, water depths, type of offshore unit, and operator's name are listed.

How to use the RIG LOCATOR. Locations of contract rigs are shown by states and counties (or parishes) in the U. S. and by province and area in Canada. If you are interested in drilling a given well in a certain county, parish, or area, in the case of Canada, and this well could be drilled most efficiently by a certain type rig, you can easily locate those contractors who operate rigs in your area of interest. If the rig you are looking for is not shown in the county where you want to drill a well, look under adjacent counties. Once the rig has been located, and the contractor's name ascertained, go back to the alphabetical listing of contractors to obtain his mailing address.

Use of abbreviations. In a directory of this type where certain specifications are included, it was necessary in the conservation of space to make some abbreviations. Under the column of "type power," the following abbreviations apply: Dsl for diesel; gaso for gasoline; stm for steam; btne for butane; and dsl elec for diesel electric. In listing drawworks make and model number, it was necessary to abbreviate the manufacturer's name. Some of these abbreviations are well known; others had to be made to fit the available space. Here's the code we used:

Manufacturer's Company Name	Abbreviation
ALCO Products, Inc. (formerly Beaumont Iron Works Div. of American Locomotive Co.)	ALCO-BIW
Allis-Chalmers Manufacturing Co.	Allis Chmrs

American Iron & Machine Works	Amer
Ansaldo	Ansaldo
Beaumont Iron Works (See ALCO Products, Inc., name no longer officially used)	ALCO-BIW
Bethlehem Supply Co.	Beth
Big Four Machine & Supply Co.	Big Four
The Brewster Co., Inc.	Brwstr
Bucyrus-Erie Co.	B. Erie
Cardwell Manufacturing Co., Inc.	Crdwll
Clark Bros. Co., Inc.	Clark
Fred E. Cooper, Inc.	Cooper
Continental-Emsco Co.	Emsco
Cummins Engine Co., Inc.	Cummins
George E. Failing Co.	Failing
Franks Division of Cabot Shops, Inc.	Frnks
General Machine Co.	Gen Mach
Hacker Machine & Supply Co.	Hacker
Hopper Machine Works, Inc.	Hopper
Houston Tool Co.	Hou
Howard-Turner Machine Works	Howard Turner
Ideco, Inc.	Ideco
Ingersoll-Rand Co.	Ingersoll
Jones, Shelburne & Guffey Co.	JS&G
Joy Manufacturing Co.	Joy
Mayhew Supply Co., Inc.	Mayhew
Lee C. Moore Corp.	L. C. Moore
Lucey Export Corp.	Lucey
Muskogee Iron Works	MIW
The National Supply Co.	Natl
Oil Well Supply Division (U. S. Steel Corp.)	"Oilwell"
Reich Bros.	Reich
Spencer-Harris Machine & Tool Co.	Spencer
Stardrill-Keystone Co.	Star
Texas Iron Works, Inc.	TIW
Unit Rig & Equipment Co.	Unit
Wagner Morehouse, Inc.	Wgnr-Mrhse
Walker-Neer Manufacturing Co., Inc.	Wlkr-Nr
Waldrip Engineering Co.	Wldrp
Well Machinery & Supply Co., Inc.	Ft. Wrth
Wheeling Machine Products Co.	Wheeling
The Wheland Co.	Whlnd
Wichita Tool Supply Co.	Wich
Wichtex Machinery Co., Inc.	Wichtex
Wilson Manufacturing Co., Inc.	Wlsn

U. S. Drilling Contractors

ROTARY AND CABLE TOOLS

ALPHABETICAL LISTING

A & P Drlg Co Inc
Box 568
Duncan Oklahoma

Abb Drlg Co
300 Oil & Gas Bldg
Wichita Falls Tex

Ace Drlg Co
1800 Republic Natl Bk Bldg
Dallas Tex

Admiral Drlg Co Inc
2030 Gulf Bldg
Houston 2 Tex

Advance Drlg Co
Box 511
Mt Vernon Ind

Akin & Dimock
714 Holliday St
Wichita Falls Tex

Alan Drlg Co
807 Oil & Gas Bldg
Wichita Falls Tex

Allen & Morris
820 Alamo Natl Bldg
San Antonio Tex

Allen Drlg Co
4410 Venable Ave
Charleston 4 W Va

W C Allen
Box 263
Oil City La

B F Allison Drlg Co
626 Patterson Bldg
Denver Colo

American Drlg Corp
Box 177
Graham Tex

Anderson Drlg Co
730 Wichita Natl Bk Bldg
Wichita Falls Tex

Andree Drlg Co
700 City Natl Bldg
Wichita Falls Tex

Anschutz Drlg Co Inc
Box 1466
Casper Wyo

An-Son Gulf Drlg Co
716 Hibernia Bldg
New Orleans La

Appell Drlg Co
Box 330
Alice Tex

Arapahoe Drlg Co
1020 Petroleum Club Bldg
Denver Colo

Armstrong & Horn Drlg Co
640 Milam Bldg
San Antonio 5 Tex

Arrow Drlg Co
407 Philtower Bldg
Tulsa Okla

Ashby Drlg Co Ltd
738 Meadows Bldg
Dallas Tex

Austin Drlg Co
Box 1240
Seminole Okla

Austin-Dunham Inc
Box 1240
Seminole Okla

Ayers & Burch
Box 1915
Wichita Falls Tex

B & B Drlg Co
Box 1285
Bakersfield Calif

B & B Drlg Co
Whitlash Mont

B B M Drlg Co
673 San Jacinto Bldg
Houston 2 Tex

B J & M Drlg Co Ltd
160 S Fairfax Ave
Los Angeles Calif

B-M Drlg Co Inc
Box 5218
Bossier City La

Badger Drillers Inc
Box 287
Tulsa Okla

Pernie Bailey
2309 Sage Rd
Houston Tex

Baird & Pfeifer Drlg Co
316 Kittredge Bldg
Denver Colo

Baker & Taylor Drlg Co
712 First Natl Bk Bldg
Amarillo Tex

Dorris Ballew Inc
Box 561
Natchez Miss

Bar-Lee Drlg Co
Box 7264
Tulsa Okla

Barnes Core Drlg Co
1350 Roberts Ln
Bakersfield Calif

Barnwell Drlg Co Inc
Box 1748
Shreveport La

Barrett Petroleum Co
423 Masonic Bldg
Shawnee Okla

Barry Well Drlg Co
West Star Rt
Fallon Nev

Basin Drlg Corp
Box 1388
Duncan Okla

Harry Bass Drlg Co
1403 Magnolia Bldg
Dallas Tex

Robert M Bass Drlg Contr
Box 471
Kilgore Tex

Beard Drlg Inc
900 NE Military Dr
San Antonio Tex

Beardmore Drlg Co
827 Beacon Bldg
Wichita Kans

Beckman Inc
Box 1524
Muskogee Okla

Dudley C Beene Inc
Suite 1117 Town House
Shreveport La

Bennett & Roberts Drlg Co
Drawer 633
Russell Kans

Bennett Drlg Co
1381 E 26th St
Tulsa 14 Okla

Bernhardt Drlg Co
2469 Grand River
Detroit 1 Mich

Berry Drlg Co
Box 67
Saint Jo Tex

L E Bever Drlg Co
1700 W Louisiana
Midland Tex

Big Chief Drlg Co
Box 8837
Oklahoma City 14 Okla

Big Horn Drlg Co Inc
Box 2068
Casper Wyo

Big Seven Drlg Co
311 Wright Bldg
Evansville Ind

Big West Drlg Co
1321 Oil & Gas Bldg
Ft Worth Tex

Big X Drlg Co Inc
2905 First Natl Bldg
Oklahoma City Okla

Bilbo-Redding Drlg Co Inc
Box 21045
Houston Tex

Black Drlg Co
525 Petroleum Bldg
Abilene Tex

Black Hills Drlg Co Inc
218½ W Main
Newcastle Wyo

Blackstock & Bradley Drlg Co
810 Braniff Bldg
Oklahoma City 2 Okla

Bodard Drlg Co
313 Masonic Bldg
Shawnee Okla

Bolin Oil Co & D H Bolin
1120 Oil & Gas Bldg
Wichita Falls Tex

Booker Drlg Co
2833 Gen Pershing
New Orleans La

Boyd & Durst Drlg Contr
Box 329
Alice Tex

Brack Drlg Co Inc
Box 575
Fort Collins Colo

E G Bradham
First Natl Bk Bldg
El Dorado Ark

Brannon & Murray Drlg Co
Box 672
Coleman Tex

Brantly Drlg Co Inc
109 Allen Bldg
Midland Tex

D J Branyan Co
Box 166
Cushing Okla

Branyan Drlg Co
Box 166
Cushing Okla

C E Brehn
Drawer 618
Mt Vernon Ill

Brewster-Bartle Drlg Co Inc
1919 Bk of Southwest
Houston Tex

Brinkerhoff Drlg Co
870 Denver Club Bldg
Denver 2 Colo

Zach Brooks Drlg Co
Box 31
El Dorado Ark

Brown & Martin Drlg Co
Box 731
Gainesville Tex

Brown & Thorp Drlg Co
Box 1358
McCamey Tex

Layton Brown Drlg Co
Box 185
Woodsboro Tex

Brown Marine Drlg Co
1456 E Hill
Long Beach 7 Calif

Harry T Bryant Drlg Co Ltd
3007 Buffalo Dr
Houston 19 Tex

Bryant-Hayward Drlg Co
Box 4627
Oklahoma City Okla

Bueno Drlg Co
425 Continental Oil Bldg
Denver Colo

Buick Drlg Inc
Box 331
St John Kans

Bullard Drlg Co Inc
Melrose Bldg
Houston Tex

A O Bullock Drlg Co
Box 821
Casper Wyo

Burger Drlg Co
Box 327
Coleman Tex

Burnham & Robinson Drlg Co
4045 N Market St
Shreveport La

Buzzini Drlg Co
541 Milam Bldg
San Antonio 5 Tex

B G Byars Power Drlg Co
318 Citizens Bk Bldg
Tyler Tex

C & S Drlg Co
2308 Transit Tower
San Antonio Tex

CBS Workover Co
1713 N Esperson Bldg
Houston Tex

C H & C Drlg Co
Box 4278
Oklahoma City 9 Okla

C N P Drlg Co
404 Staley Bldg
Wichita Falls Tex

C-P Drlg Co
Box 1821
Pampa Tex

Cactus Drlg Corp of Tex
Box 348
San Angelo Tex

Calco Drlg Co
1113 Continental Bk Bldg
Ft Worth Tex

Calvert Drlg Inc
204-S Fair St
Olney Ill

Camay Drlg Co
Box 391
Compton Calif

Camay Drlg Co
Rocky Mt Div
Box 1496
Denver Colo

Camdrill International Inc
c/o Camay Drlg Co
Box 391
Compton Calif

Canadian River Drlg Co
424 Petroleum Bldg
Amarillo Tex

Capitan Drlg Co Inc
Box 671
Odessa Tex

Capitt Drlg Co
814-16 Union Center
Wichita Kans

Frank Caraway Drlg Co
Box 982
San Angelo Tex

Cardinal Drlg Co
Elks Office Bldg
Bismarck N D

Carmack Drlg Co
1008 Mile High Center
Denver Colo

Carpenter-Trant Drlg Co
203 C A Johnson Bldg
Denver 2 Colo

Carper Drlg Co Inc
Box 509
Hobbs N M

Carter Drlg Co
462 S Pershing
Wichita Kans

Carter-Jones Drlg Co
Box 1597
Kilgore Tex

Casner & Bentz
Box 666
Oildale Calif

Central Drlg Co
Box 44
Fairfield Ill

Central Drlg Co
704 10th St
Lawrenceville Ill

Chambless-Rosen Drlg Co
Box 4294
Oklahoma City Okla

Ford Chapman
Hubbs-Roberson Bldg
Pecos Tex

Chessher Sutton & Davis Drlg Co Inc
366 San Jacinto Bldg
Houston 2 Tex

Chiles Drlg Co
Box 949
Alice Tex

Cecil Chisler & Son
Route 2
Fairview W Va

Choate & Hitt
Box 310
Cisco Tex

Choya Drlg Co Inc
500 W Illinois
Midland Tex

Circle Drlg Co Inc
620 Pioneer Bldg
Lake Charles La

Dan L Clark Drlg Co
819 Wilson Tower
Corpus Christi Tex

Clark Drlg Co
Box 1743
Billings Mont

Clark Fuel Prod Co
Box 473
Mission Tex

R L Bob Clark Drlg Contr
Box 1933
Kermit Tex

Claypool Drlg Co
St Elmo Ill

Clegg & Hunt
715 Houston Club Bldg
Houston Tex

Clinch Drlg Co
Box 27
Hazelhurst Miss

Coastal Drlg Co
7300 La Hore Rd
Bakersfield Calif

Coastal Marine Drlg & Constr Co
450 Bk of the Southwest Bldg
Houston 2 Tex

Collier Drlg Co
Artesia Hotel
Artesia N Mex

Colorado Wyoming Drlg Co
1119 Mile High Center
Denver Colo

Columbia Drlg Co
1207 C & I Life Bldg
Houston 2 Tex

Comet Drlg Co
Box 1143 OCS
Lafayette La

Compagnia Industries
Metanifere E Affine
(Rome Italy)
Box 2012
Tyler Tex

Conroe Drlg Co
Drawer 1741
Corpus Christi Tex

Continental Drlg Co
413 Shell Bldg
New Orleans La

Continental Shelf Drlg Co
223 Internatl Trade Mart Bldg
New Orleans La

Cook Drlg Co
2305 Continental Life Bldg
Ft Worth Tex

Cooper Drlg Co
902 Staley Bldg
Wichita Falls Tex

R A Cooper Drlg Co
711 Hulman Bldg
Evansville Ind

Coral Drlg Co
414 Shell Bldg
New Orleans La

Coroco Drlg Co
2807 Mercantile Bk Bldg
Dallas Tex

Cortex Drlg Co
1700 Broadway
Denver Colo

Crawford Drlg Co
Box 622
Shreveport La

Cree Drlg Co Inc
Box 1821
Pampa Tex

Criswell Drlg Co
Box 253
Arkansas City Kans

Cren & Gracey Corp
1100 Houston Club Bldg
Houston Tex

Crew Drlg & Prod Co
2000 Beck Bldg
Shreveport La

Milton Crew Inc
Commercial Natl Bk Bldg
Shreveport La

Crowe Drlg Co
211 Perkins Bldg
Duncan Okla

Crown Rigs Inc
2107 Bk of the Southwest Bldg
Houston Tex

Sam E Crump Drlg Co
408 Union Bldg
Midland Tex

Harry L Cullet
Purefoy Hotel
Talladega Ala

D & J Drlg Co
Rt 2 Box 219-A
Okemah Okla

D & M Drlg Co Inc
Box 247
Great Bend Kans

D-K Drlg Co
Box 866
Cortez Colo

Clark Dale Drlg Co Inc
308 N Colorado Ave
Midland Tex

Danforth Drlg Co
418 Kennedy Bldg
Tulsa Okla

R W Darden Drlg Co
Box 574
Olney Tex

R A Davenport Drlg Contr
211 Perkins Bldg
Duncan Okla

Davidson Drlg Co Inc
1004 Continental Life Bldg
Ft Worth Tex

Edgar Davis Drlg Co
717 Citizens Bk Bldg
Abilene Tex

Harvey Davis & Robt H Thompson Co
1731 28th St
Bakersfield Calif

Dearing Inc
Box 655
Dallas Tex

Deepwater Expl Co
1109 Tex Natl Bk Bldg
Houston Tex

Delaney Drlg Co
Box 881
Ada Okla

M J Delaney Co
512 Continental Bldg
Dallas 1 Tex

Dellson Drlg Co
U S Natl Bk Bldg
Denver Colo

Del Mar Drlg Co
409 Oil Industries Bldg
Corpus Christi Tex

Delta Drlg Co
Box 2012
Tyler Tex

Delta Marine Drlg
Box 2012
Tyler Tex

The Denver Co
1904 Great Plains Life Bldg
Lubbock Tex

Denver Drlg Corp
Box 669
Odessa Tex

Dillard-Waltermire Inc
Oil & Gas Bldg
Houston 2 Tex

W L Dillier
Box 341
Casey Ill

Dillingham Drlg Co
Box 1346
Alice Tex

Dixie Drlg Co Inc
1712 Commerce Bldg
Houston 2 Tex

Dixilyn Drlg Corp
Box 3427
Odessa Tex

Dixon Drlg Co
Box 2320
Abilene Tex

Doak Drlg Co
Box 1108
Bristow Okla

Doc Drlg Corp

Blackie Drlg Co Inc

Neva-Andre Drlg Corp
210 Willow St
Franklin La

Donnell Drlg Co
607 Texas Bk Bldg
Dallas Tex

Douglas Drlg Co
Box 748
Oildale Calif

Drillers Inc
2005 Adolphus Tower
Dallas Tex

Drlg & Expl Co of Delaware Inc
600 Exchange Bk Bldg
Dallas Tex

Drlg & Prod Co
2907 L St
Bakersfield Calif

Drill Well Oil Co
1502 8th St
Wichita Falls Tex

Dual Drlg Co
606 City Natl Bk Bldg
Wichita Falls Tex

Dudley & Heath Drlg Co
Box 428
Stillwater Okla

B A Duffy Drlg Co
Rm 100 Crescendo Bldg
Abilene Tex

N V Duncan Drlg Co
303 Oil & Gas Bldg
Oklahoma City Okla

Dunnam & Wyant Drlg Co
816 N Jordan
Liberal Kans

Durham Drlg Co Inc
Box 204
Midland Tex

Dyer Drlg Co
Box 338
Casper Wyo

Dykes Drlg Co
200 Petroleum Bldg
San Angelo Tex

E & H Drlg Co
Box 1058
Graham Tex

E & M Well Serv Co
223½ N Second
Seminole Okla

Eakle & Holder Drlg Co
116 Mulberry St
Evansville Ind

T T Eason & Co Div of Eason Oil Co
1211 Colcord Bldg
Oklahoma City 2 Okla

Eastern Drlg Inc
Box 291
Carmi Ill

Eastland Drlg Co
806 Continental Life Bldg
Ft Worth Tex

Edwards & Bissett Inc
1912 N Esperson Bldg
Houston Tex

Edwards Drlg Co
Box 1140
Graham Tex

Harry L Edwards Drlg Co
Box 6825
Houston Tex

Errol Elkins Drlg Co
460 Rio Grande St
Eagle Pass Tex

Empire Drlg Co
1507 Mercantile Bk Bldg
Dallas Tex

Empire Drlg Co
400 Brown Bldg
Wichita Kans

Empire States Drlg Corp
1020 Simms Bldg
Albuquerque N M

Enterprise Oil Co
7440 La Hore Rd
Bakersfield Calif

Ewing Drlg Co
Box 807
Breckenridge Tex

Exeter Drlg Co
Republic Natl Bk Bldg
Dallas 1 Tex

Exploration Drlg Co
607 Natl Bk of Tulsa Bldg
Tulsa Okla

Fain-Porter Drlg Corp
2410 First Natl Bldg
Oklahoma City Okla

Fairman Drlg Co
Hammersley Fork Pa

Falco Drlg Co Inc
Box 1255
Alice Tex

Falcon Seaboard Drlg Co
Pan American Bldg
Tulsa Okla

Felderhoff Bros Drlg Co
Box 87
Muenster Tex

Fen-Par Expl Co Inc
Box 282
Grand Haven Mich

Ferbanta Drlg Co
Box 107
Carmi Ill

Field Drlg Co
1900 Milam Bldg
San Antonio Tex

Jim Fish Drlg Co
Box 655
Iowa Park Tex

Fitzpatrick Drlg Co
803 Wilson Tower
Corpus Christi Tex

Fleeger Drlg Inc
271 Meadows Bldg
Dallas 6 Tex

J B Fletcher Drlg Co
306 Ricou-Brewster Bldg
Shreveport La

Flournoy-Haston Drlg Co Inc
1005 Davis
Ardmore Okla

Folk Drlg Co
614 Main
Yukon Okla

Foree Drlg Co
602 First Natl Bk Bldg
Dallas Tex

Fortune Drlg Corp
Petroleum Bldg
San Angelo Tex

C J Foster Drlg Co Inc
Box 657
Richmond Tex

Foster Drlg Co
Box 751
Cushing Okla

4-J Drlg and Well Serv Co
Box 471
Drumright Okla

Armstrong Fowler Inc
929 Oleander
Bakersfield Calif

Frank Frawley Drlg Co
823 S Detroit
Tulsa 3 Okla

Lloyd R French Co
506 V & J Tower
Midland Tex

Frio Drlg Inc
506 Driscoll Bldg
Corpus Christi Tex

Frisbie Drlg Inc
402 Pan American Bldg
Tulsa 3 Okla

Fryer & Hanson Drlg Co
2520 Republic Natl Bk Bldg
Dallas Tex

Gabbert-Jones Drlg Co
514 Orpheum Bldg
Wichita Kans

Gardner Bros Drlg Co Inc
1708 Davis Bldg
Dallas Tex

Buster Gardner Drlg Co Inc
Box 281
New Iberia La

Garr-Woolley Oil Co
901 Cravens Bldg
Oklahoma City Okla

Garvey Drlg Co
Route 2
Great Bend Kans

Gary Drlg Co
Box 58
Oil City La

General Drlg Co
Colcord Bldg
Oklahoma City Okla

General Well Drlg Co
Box 1315
Alice Tex

Gibson Drlg Co
Box 1540
Kilgore Tex

Gilger Drlg Co
831 N Esperson Bldg
Houston 2 Tex

Glenn Gillespie & Sons
Box 907
Cushing Okla

Gilmour Drlg Co
Box 1082
Alice Tex

C G Glasscock Drlg Co
1601 Wilson Tower
Corpus Christi Tex

Glasscock-Wilson Inc
1604 Beck Bldg
Shreveport La

F E Gober Drlg Co
3032 Cherry Ave
Long Beach Calif

Goe Drlg Co
Box 5
Perry Okla

Goff-Leeper Drlg Co
Box 457
Ardmore Okla

Gold-Mar Drlg Co
Box 732
Dewar Okla

Goldsmith Drlg Co
Box 750
Duncan Okla

Gordon Drlg Co
Box 15
Mt Pleasant Mich

Gore Drlg Co
Box 515
Albany Tex

T V Gorman
621 Staley Bldg
Wichita Falls Tex

Jack Grace Drlg Contr
1009 City Natl Bk Bldg
Wichita Falls Tex

Gracey-Hellums Corp
410 S Coast Bldg
Houston 2 Tex

Burdette Graham
804 Driscoll Bldg
Corpus Christi Tex

Graham Drlg Co
2nd Floor First St Bk Bldg
Temple Okla

Graham-Michaelis Oil Co
211 N Broadway
Wichita 7 Kans

Grannell Drlg Co
Box 583
Casper Wyo

Graves Drlg Co
Box 583
Ardmore Okla

Gray Drlg Co
220 Wichita Natl Bk Bldg
Wichita Falls Tex

Great Western Drlg Co
Box 1659
Midland Tex

Green & Dreblow Drlg Co
Box 1057
Bakersfield Calif

Green & Heiser Drlg Co
Box 3098
Bakersfield Calif

Greenland Drlg
Box 518
Great Bend Kans

Greenwood Petroleum Mgmt Inc
Eureka Kans

Greyhound Drlg Co Inc
Box 7334
Shreveport La

Grey Wolf Drlg Co
1506 Bk of the Southwest
Houston Tex

Guadalupe Drlg Co
2505 Princeton Ave
Midland Tex

Roy Guffey Drlg Co
5543 Yale Blvd
Dallas 6 Tex

Gulf Coast Drlg & Expl Inc
Box 2367 Choctaw Sta
Laurel Miss

Gulf Coast Western Oil Co
Republic Bldg
Oklahoma City Okla

Henry Gwaltney Drlg Co
Box 289
Washington Ind

H & S Drlg Co
Drawer 518
Dewey Okla

H & S Drlg Co
407 Tri State Ins Bldg
Tulsa Okla

H E R Drlg Co
724 W Britton Ave
Oklahoma City Okla

Hack Drlg Co
Box 1636
Abilene Tex

John S Hagestad Drlg Co
3224 Gulf St
Bakersfield Calif

Halbert Drlg Co
507 Citizens Bk Bldg
Tyler Tex

Hale Bros Drlg Co
315-B City Natl Bldg
Wichita Falls Tex

Clyde Hall Drlg Co Inc
Box 107 Sta B
Bakersfield Calif

O E Hall Drlg Co
2008 Continental Natl Bk Bldg
Ft Worth Tex

Hamilton-Powell Drlg Co Inc
1220 Hamilton Bldg
Wichita Falls Tex

Hamman Oil & Ref Co
Box 13028
Houston 19 Tex

F E Hargraves & Son Drlg Co
Box 573
Oil City La

Harkins & Co
Box 1490
Alice Tex

Harms-Burt Drlg Co
510 Petroleum Bldg
Wichita Kans

Harrell Drlg Co
1228 Bk of Southwest Bldg
Houston 2 Tex

Harris Drlg Co
Box 699
Grayville Ill

John W Harris Drlg Co
525 Wichita Natl Bk Bldg
Wichita Falls Tex

C H Hartman
206 Security Bldg
Sapulpa Okla

J W Hastings Drlg Co
Wichita Natl Bk Bldg
Wichita Falls Tex

Hatfield Drlg Co Inc
1611 N "H" St
Midland Tex

Hawkins-Wilkins Prod Co
373 San Jacinto Bldg
Houston Tex

Win Hawkins Drlg Co
373 San Jacinto Bldg
Houston 2 Tex

Hayward Drlg Co
Box 295
Enid Okla

John Heard & Co Inc
Rm 4 Elm Oil Bldg
Tulsa Okla

Helmerich & Payne Inc
First Natl Bldg
Tulsa Okla

Henderson Drlg Corp
N Esperson Bldg
Houston Tex

The Herb Expl Co
342 Lexington Ave
Abilene Tex

Herndon Drlg Co
Drawer 489
Tulsa Okla

Herring & Davis
607 Kennedy Bldg
Tulsa Okla

Maxwell Herring Drlg Corp
Box 1122
Kilgore Tex

B M Hester
Box 2588
Wichita Falls Tex

Hewgley Drlg Co
704 Wilco Bldg
Midland Tex

Hewit-Gulick Drlg Co
240 Silver State Bldg
Denver 2 Colo

Highland Drlg Co
Box 671
Odessa Tex

Highland Oil
Box 263
Jasper Ind

Hilburn Industries Inc
Ricou-Brewster Bldg
Shreveport La
Hill Drlg Co
Box 532
Conroe Tex
J E Hillier
Box 67
Pleasanton Tex
Hills & Hills Drlg Co
Box 2158
Pampa Tex
C F Hills Drlg Co
Box 2158
Pampa Tex
W B Hinton
Mercantile Building
Dallas 1 Tex
Hissom Drlg Co
1327 Wilco Bldg
Midland Tex
Hoagland Drlg Co Inc
108 N Lincoln St
Robinson Ill
Holliman Drlg Co
712 Fidelity Union Life Bldg
Dallas Tex
Holm Drlg Co
Box 7246
Tulsa Okla
Holmes Drlg Co
1045 San Jacinto Bldg
Houston Tex
Holt Brothers Drlg Co
Box 236
Pampa Tex
W C Holt Drlg Co Inc
909 Enterprise Bldg
Tulsa Okla
Slats Honeymon Drlg Co
1310 Liberty Bk Bldg
Oklahoma City Okla
R L Horn & Son Drlg Co
Pawnee Okla
Hose-Austin Drlg Corp
Box 1067
Casper Wyo
Houchins Drlg Co
Box 388
Mt Carmel Ill
Housh Drlg Co
586 Gulf Bldg Addn
Houston 2 Tex
Houston Oil Well Serv Co
1706 C & I Life Bldg
Houston 2 Tex
H H Howell
801 Milam Bldg
San Antonio Tex
Howell Holloway & Howell
Life of America Bldg
Dallas Tex
Hull Oil Co
214 Panhandle Bldg
Wichita Falls Tex
Hunt Drlg Co Inc
634 Wilson Bldg
Corpus Christi Tex
Hupp & Hume
Box 616
Owensboro Ky
Floyd R Hyer
Commerce Bldg
Okmulgee Okla
Hylton Drlg Co
716 Eye St
Bakersfield Calif
Index Drlg Co
Box 918
Laurel Miss
Indian Drlg Co
Box 42
Tulsa Okla
Donald T Ingling
623 First Natl Bk Bldg
Wichita 2 Kans
Irish Drlg Co Inc
Box 225
Eastland Tex

Isern Drlg Co
Box 45
Ellinwood Kans
Ivy Drlg Co
1705 Burton Way
Bakersfield Calif
J & C Drlg Co
Box 552
Refugio Tex
J & L Drlg Co Ltd
2005 Adolphus Tower Bldg
Dallas Tex
J M C Drlg Interests
6282 E Marshall
Tulsa Okla
S W Jack Drlg Co
Allegheny Ave
Avonmore Pa
A L Jackson Drlg Co
Box 194
Great Bend Kans
Jackson Drlg Co
Box 1388
Duncan Okla
Jennings Drlg Co
612 City Natl Bk Bldg
Wichita Falls Tex
Jett Drlg Co Inc
Box 1832
Shreveport La
Johns Drlg Co
711 Fair Bldg
Ft Worth Tex
Johnson & Flesher Drlg Co
601 Hightower Bldg
Oklahoma City Okla
Al Johnson Drlg Co
Rt 12 Box 440
Oklahoma City 10 Okla
Johnson-Bates Drlg Co
Box 425
Konawa Okla
Johnson Drlg & Serv Co
Box 3
Magnolia Ark
Fred Johnson Drlg Co
2790 Cherry Ave
Long Beach Calif
Johnson-Gadbois Drlg Co
200 Petroleum Bldg
Abilene Tex
S D Johnson
304 Mile High Center
Denver Colo
Don Johnston Drlg Co
825 Petroleum Club Bldg
Denver Colo
Jonco Drlg Co
Box 1214
Seminole Okla
Buck Jones Drlg Co
Box 1085
McCamey Tex
J E Jones Drlg Co
Box 2218
Midland Tex
Jones Well Serv Co
Box 609
Abilene Tex
Woody Jones Drlg Co
408 E Main St
Olney Ill
Julkirk Corp
506 V & J Tower
Midland Tex
Justiss-Mears Oil Co
Box 396
Jena La
K & S Drlg Co
First Natl Bldg
Bartlesville Okla
Karper & Glass
Box 149
Graham Tex
Keating Drlg Co
510 Natl Bk of Tul Bldg
Tulsa Okla

Kee & Simpson Drlg Co
417 S Hill St
Los Angeles 13 Calif
K L Kellogg & Sons
Box 510
Compton Calif
Kelly Drlg Co
Box 1126
Houma La
Kendall-Davis Drlg Co Inc
201 SE 1st St
Evansville Ind
Kent Drlg Co
Box 2555
Salt Lake City Utah
Keoughan Drlg Co
Box 9368
Ft Worth 7 Tex
Kern Drlg Co Inc
Box 936
Magnolia Ark
Kerr-McGee Oil Industries Inc
Kerr McGee Bldg
Oklahoma City Okla
Kersey & Co
Box 305
Artesia N Mex
Keyes Drlg Co
Box 1108
Roswell N Mex
Kilroy Drlg Co
2306 Bk of Southwest Bldg
Houston Tex
Carl B King Drlg Co of Tex
Box 270
Midland Tex
Kingery Drlg Co Inc
Box 97
Saint Jo Tex
King-Phillips Inc
1109 Continental Natl Bk Bldg
Ft Worth Tex
Kirby Oil Ind
5107 Center St
Omaha 6 Neb
Hugh Kirkpatrick Inc
Box 312
Mission Tex
A F Knappenberger and K & H Drlg Co
427 Elm St
Graham Tex
Donald P Knierim
Box 277
Casey Ill
Knight Drlg Co
Box 1332
Bakersfield Calif
Tom Knight
3086 Garden Ave
Billings Mont
Kuehn & Roberts Drlg Contrs
508 Mims Bldg
Abilene Tex
A J Kuenstler Drlg Co
Box 1374
Alice Tex
Kullberg & Otthouse Inc
Box 967
Cut Bank Mont
L & F Drlg Co
Box 1468
Bakersfield Calif
L & H Drlg Co
3331 Lorraine St
Baton Rouge La
L & N Drlg Co
6709 Canal Blvd
Shreveport La
Ralph G Ladd
Box 5
Haskell Okla
Lake Drlg Co
1417 Church
Beaumont Tex
La Mance Drlg Co
Box 2686
Midland Tex

Lamar Drlg Corp
Box 4128 Centenary Sta
Shreveport La
Larco Drlg Co
Box 3499
Jackson Miss
Howard C Lasiter Drlg Co
Box 172
Grandfalls Tex
Laughlin-Porter Drlg Co Inc
11 Petroleum Life Bldg
Midland Tex
J W Lawrence
Box 942
Conrad Mont
Roy Lawrence Drlg Co
Box 306
Pawnee Okla
Layton and Newell Drlg Co
1321 Oil & Gas Bldg
Ft Worth Tex
Leatherwood Drlg Co
Box 925
Jacksboro Tex
Lee Drlg Co
1007 Philtower Bldg
Tulsa Okla
D H Lesh Drlg Co
Box 505
Mattoon Ill
Lewis & Mucher Drlg Corp
Box 2067
Longview Tex
Lewis Bros Inc
320 Mile High Center
Denver 2 Colo
Lewis Drlg Co
915 Union Center
Wichita Kans
Lincoln Drlg Co
403 Oil & Gas Bldg
Oklahoma City Okla
Ted Lindsay Drlg Contr
Box 190
Mt Vernon Ill
M M Lindsey Drlg Co
4748 Airline Hwy
Baton Rouge La
H J Lininger
Box 37
Upper Sandusky Ohio
Lin-Mour Drlg Co
Oil & Gas Bldg
Wichita Falls Tex
Livermore Drlg Co
406 Lubbock Natl Bk Bldg
Lubbock Tex
Llano Drlg Co
301 V & J Tower Bldg
Midland Tex
Loffland Bros Co
Box 1649
Tulsa Okla
Lofton Oil Co
707 Oil & Gas Bldg
Wichita Falls Tex
Lohmann-Johnson Drlg Co Inc
320 Indiana Bk Bldg
Evansville Ind
Lomax Drlg Co
Box 584
Midland Tex
Charles E Long Jr Inc
Box 961
Midland Tex
Longhorn Drlg Corp
Box 546
Three Rivers Tex
Louisiana Delta Offshore Corp
201 Carondelet Bldg
New Orleans La
Lowe Drlg Co
Box 832
Midland Tex
Lusk Drlg Co
No 11 U-Totem Lane
Houston 24 Tex
Lynn Drlg Co
1403 Natl Bk of Tul Bldg
Tulsa Okla

H B Lynn Drlg Corp
Box 1085
Farmington N Mex
M-H-O Drlg Co
Box 297
Cut Bank Mont
MIM Drlg Corp
1401 Majestic Bldg
San Antonio Tex
Mac Drlg Co
Box 2972
Houston Tex
Macrate Prod Co
3341 Cherry Ave
Long Beach 7 Calif
Mac's Drlg Co
1531 High Box 3
Grand Junction Colo
Makin Drlg Co
Box 1628
Hobbs N Mex
Mallard Drlg Co
1016 Union Natl Bk Bldg
Wichita Kans
Malonee Drlg Co Inc
820 Union Center
Wichita Kans
Mangum Drlg Co
834 Esperson Bldg
Houston Tex
R L Manning Co
318 Continental Oil Bldg
Denver Colo
Marcum Drlg Co
Box 761
Ada Okla
Marlin Exploration Inc
836 Olive
Shreveport La
M L (Mike) Marrs Drlg Co
Box 985
Drumright Okla
Martin & Holmes Oil Well Serv Co
4730 Ayers
Corpus Christi Tex
Lubie Martin Drlg Co
2052 Harvard
Houston Tex
Maxwell Drlg Co
Box 846
Coleman Tex
M Mazzarino
Staunton Ill
McAlester Fuel Co
Box 210
Magnolia Ark
Gabe McCall Drlg Co
Box 2068
Casper Wyo
McClure Oil Co
Box 147
Alma Mich
McCutchen & Graham
409 Oil & Gas Bldg
Wichita Falls Tex
Gene McCutchin
Box 1585
Dallas Tex
Jerry Alex McCutchin Drlg Co
Mercantile Sec Bldg
Dallas Tex
McDaniel & Beecherl Drlg Co
607 Davis Bldg
Dallas Tex
McDaniel Drlg Co
205 C A Johnson Bldg
Denver 2 Colo
A D McDuffie
Box 807
Wichita Falls Tex
Lottie B McFann Drlg Co
3901 Cedar Ave
Long Beach 7 Calif
W H McGarr Industries
Box 826
Coleman Tex
J R McGill
509 Amarillo Bldg
Amarillo Tex

McGoldrick & Watson Drlg Co
213 Beck Bldg
Shreveport La
McQueen & Stout Drlg Co
1113 Ft Worth Natl Bk Bldg
Ft Worth 2 Tex
Meadows & Walker Drlg Co
500 San Jacinto Bldg
Houston 2 Tex
Meico Drlg Co
Box 1360
Seminole Okla
Mercury Drlg Corp
1205 Beck Bldg
Shreveport La
Meredith & Co
1418 Bk of the Southwest Bldg
Houston Tex
Meredith Drlg Co
419 City Natl Bldg
Wichita Falls Tex
Ward S Merrick
Box 971
Ardmore Okla
Mesker Drlg Co
1129 E 15th St
Tulsa Okla
Midland Drlg Co
410 W Ohio
Midland Tex
Midwestern Drillers Inc
1206 Mid-Continent Bldg
Tulsa 3 Okla
Milam Drlg Co
1814 Alamo Natl Bldg
San Antonio Tex
J Conley Miles Drlg Co
Box 1791
Abilene Tex
Milestone Drlg Co
Box 2745
Midland Tex
Milhoan Drlg Co
Box 948
Tulsa Okla
Miller & York
Box 936
Bakersfield Calif
Miller Bros & Bowling
Box 611
Alice Tex
J E Miller Drlg Contr
Box 1581
Abilene Tex
Miracle-Fifer Drlg Co
1636 Welton St
Denver 2 Colo
Mobile Drlg Co
705 Fourth Natl Bk Bldg
Wichita 2 Kans
Mobile Drlg & Well Serv Co Inc
Box 207
Conroe Tex
Montgomery Drlg Co
Box 747
El Dorado Ark
J S Montgomery
103 NW 44th St
Oklahoma City Okla
Moore & Moore Drlg Co
Box 29
Abilene Tex
Lamar H Moore Drlg Co
Box 29
Abilene Tex
Mora Drlg Co
1908 First Natl Bldg
Tulsa Okla
Moran Bros Inc
1200 Oil & Gas Bldg
Wichita Falls Tex
E W Moran Drlg Co
500 First Natl Bk Bldg
Wichita Falls Tex
Moran Oil Prod & Drlg Corp
Box 1718
Hobbs N Mex

Dave Morgan Drlg Co
Box 820
Blackwell Okla

Pete Morris Drlg Co
Box 733
Ada Okla

Morrison Drlg Co Inc
Box 583
Casper Wyo

Mosier & King Well Serv Inc
Box 102
Abbeville La

Mountain States Drlg Co Inc
622 Patterson Bldg
Denver Colo

Movible Offshore Co
San Jacinto Bldg
Houston Tex

Murphy & McKernan
Box 169
Pampa Tex

Bob Murphy
Box 5
Pawhuska Okla

Musgrove Petroleum Corp
801 Union Center
Wichita Kans

Muskegon Development Co
432 Lyman Bldg
Muskegon Mich

Mustang Drlg Corp
1201 Peoples Bk Bldg
Tyler Tex

Muzny Drlg Co
Box 745
Prague Okla

C L (Cluke) Myers Drlg Co Inc
317 E Ninth St
Wewoka Okla

Myers Drlg Serv
2117 Bank St
Bakersfield Calif

Neal Drlg Co
Box 423
Victoria Tex

Needham Drlg Co
Box 1285
Artesia N Mex

Nelson Drlg Co
300 W Main
Ardmore Okla

Nemaha Oil Co
Mercantile Bk Bldg
Dallas Tex

Newton Drlg Co
Box 1104
Coalinga Calif

Nichols Drlg Co
Box 1032
Duncan Okla

The Noah Petroleum Co
Box 192
Albion Ill

George Noland Drlg Co Inc
823 S Detroit Ave
Tulsa 20 Okla

Norman Oil Corp
1141 Butternut St
Abilene Tex

Norton Drlg Co
542 Natl Bk of Commerce Bldg
New Orleans 12 La

William A Norton
6516 NW Grand Blvd
Oklahoma City Okla

Norwood Drlg Co
700 Wichita Natl Bk Bldg
Wichita Falls Tex

Nowery Drlg Co Inc
5904 Fairfield
Shreveport La

Nuckolls-Bell Drlg Co
1255 First Natl Bldg
Oklahoma City 2 Okla

Nye & Snell Drlg Co
208 Patterson Bldg
Denver Colo

Ocean Drlg & Expl Co
918 Carondelet Bldg
New Orleans 12 La

Olds & Wrather Drlg Co
Box 113
Casper Wyo

Bob Olds Drlg Co
Box 113
Casper Wyo

R Olsen
Liberty Bk Bldg
Oklahoma City Okla

W B Omohundro
Box 774
Wichita Falls Tex

O'Neal Drlg Co
1314 Oil & Gas Bldg
Ft Worth Tex

Oney Drlg Co
Box 425
Graham Tex

Ormand Bros Drlg Co
Box 1469
Odessa Tex

O'Rourke-McGirl Drlg Corp
632 Natl Bk of Tul Bldg
Tulsa Okla

Overby Drlg Co Inc
Box 248
Nowata Okla

Owen Drlg Co
Box 1423 OCS
Lafayette La

Haynes B Ownby Drlg Co
1610 Gulf States Bldg
Dallas Tex

Paco Petroleum Corp
Box 347
Mt Carmel Ill

Paine Drlg Co
301 Insur-O-Medic Bldg
Dallas Tex

Pan-Tex Drlg Co
316 Henderson Blvd
Kilgore Tex

Parker Drlg Co
418 Natl Bk of Tul Bldg
Tulsa Okla

Patton Drlg Co Inc
Orpheum Bldg
Wichita Kans

Payne Bros Drlg Co
1411 10th St
Lawrenceville Ill

Peak Drlg Co Inc
1019 Central Bldg
Wichita Kans

Pegg Bros Drlg Co
1204 Natl Bk of Commerce Bldg
San Antonio Tex

Penrod Drlg Co
418 Market St
Shreveport La

Perforaciones Delta C A
Apartado 9138
Caracas Venezuela

Perkins Bros Drlg Co
Box 1232
Duncan Okla

Perrine & Perrine Drlg Contr
Box 87
Salem Ill

L C Peters Drlg Contr
First Natl Bk Bldg
Longview Tex

Petersen Petroleum Corp
836 Olive
Shreveport La

Petro Drlg Co Inc
Box 339
Mt Vernon Ill

Petrolex Inc
361 Palmtag
Hollister Calif

R P Phillips Well Serv
Box 246
Lafayette La

Pickrell Drlg Co
705 Fourth Natl Bk Bldg
Wichita 2 Kans

Pierce Drlg Co
605 Oil & Gas Bldg
Wichita Falls Tex

Pioneer Drlg Co Inc
Box 2211
Casper Wyo

Louis Pitcock Drlg Co
Box 25
Graham Tex

Jack Plemons Drlg Co
Box 1493
Artesia N Mex

Pool & Gerlich Drlg Co
Box 1940
San Angelo Tex

Fred Pool Drlg Co
Box 172
Abilene Tex

Porter Drlg Co
317 Oil Capitol Bldg
Tulsa Okla

Poteet Wysor & Eckles Inc
Box 508
Holdenville Okla

Powell Drlg Co
412 Union Center Bldg
Wichita Kans

Graham Powell Drlg Co
129 N Sycamore St
Centralia Ill

The Power Rig Drlg Co
Box 1436 OCS
Lafayette La

Prime Drlg Co
814-16 Union Center
Wichita Kans

Prince Marine Drlg & Expl Co
434 Bk of Southwest Bldg
Houston Tex

Princeton Mining Co
111 N 7th St
Terre Haute Ind

T M Pruett Drlg Contr
Box 303
Centralia Ill

Pyburn Drlg Co
Box 4276
Shreveport La

R & R Well Serv Co
Box 637
Rangely Colo

R W I T Drlg Co
506 Diamond St
Holdenville Okla

Frank Raiborn Drlg Co
35 Garden Rd
San Angelo Tex

Ramey Well Serv
Suite 401P Robertson Bldg
Wichita Falls Tex

G H Ray Well Serv
Box 68
Cement Okla

Slim Rea Drlg Co
Box 399
Abilene Tex

Reading & Bates Inc
1502 Philtower Bldg
Tulsa 3 Okla

Reading & Bates Offshore Drlg Co
1502 Philtower Bldg
Tulsa 3 Okla

Reagan Drlg Co
1576 Carol Lane
Wichita Falls Tex

Red River Drlg Co
Cook Bldg
Breckenridge Tex

Reed Drlg Co
1209 Atlas Bldg
Tulsa Okla

Gene Reid Drlg Inc
3505 Pierce Rd
Bakersfield Calif

Reliable Drlg Co Inc
3086 Garden Ave
Billings Mont

Reserve Drlg Co Inc
Drawer 1612
Casper Wyo

Reserve Drlg Co Inc
625 Union Center Bldg
Wichita 2 Kans

Revier Drlg Co
208 City Natl Bk Bldg
Wichita Falls Tex

Rex & Morris Drlg Co
Box 334
El Dorado Kans

Rheay & Reynolds Drlg Co
404 Petroleum Bldg
Abilene Tex

Rhodes & Hicks Drlg Corp
Box 1395
Alice Tex

Riceland Corp
Box 747
Dallas Tex

Marvin S Ridgeway
Box 943
Beeville Tex

George W Riley Inc
Box 826
Odessa Tex

Rimrock-Tidelands Inc
1315 Gravier St
New Orleans La

The R W Rine Drlg Co
420 Union Center
Wichita Kans

C M Roberson Drlg Co
418 Market St
Shreveport La

Robinson-Wehmeyer
470 San Jacinto Bldg
Houston Tex

Rocket Drlg Co
2099 E 27th St
Long Beach Calif

Rocket Drlg Co Inc
352 N Broadway
Wichita Kans

Rocky Mountain Drlg Co
550 S Flower St
Los Angeles Calif

Dwight M Ross Drlg Co
Hamilton Bldg
Wichita Falls Tex

R Benton Ross Inc
403 P Robertson Bldg
Wichita Falls Tex

Don M Rounds Drlg Co Inc
925 Petroleum Club
Denver 2 Colo

Rowan Drlg Co Inc
Drawer 12247
Ft Worth 16 Tex

B L Rucker Drlg Co
Box 127
Mt Vernon Ill

Ruhl Drlg Co Inc
1621 Bk of Southwest Bldg
Houston 2 Tex

Rupp-Ferguson Oil Co
522 Union Center Bldg
Wichita Kans

Russell & Russell Drlg & Prod
621 Lindsay St
Gainesville Tex

Paul F Rutledge
Box 2239
Santa Fe N Mex

Sabre Drlg Co
222 Hughes Bldg
Cushing Okla

St John Drlg Co
Box 639
Ballinger Tex

Salt Dome Prod Co
737 Texas Natl Bk Bldg
Houston 2 Tex

Santa Fe Drlg Co
Box 310
Whittier Calif

Santa Maria Drlg Corp
2875 Cherry Ave
Long Beach 6 Calif

Santa Rosa Drlg Co
Box 633
Apple Valley Calif

Saunders Drlg Inc
Box 5383
Sonora Tex

Scat Drlg Co Inc
Box 787
Drumright Okla

Schafer Drlg Co
2400 Liberty Bk Bldg
Oklahoma City Okla

J B Schick Drlg Co
510 Petroleum Bldg
Abilene Tex

Schimmel Drlg Co
2121 Alamo Natl Bldg
San Antonio Tex

A L Schlaikjer
Box 761
Newcastle Wyo

Schoenfeld-Hunter-Kitch Drlg Co
Box 588
Tulsa 1 Okla

Schulz & Brannan Drlg Co
621 Staley Bldg
Wichita Falls Tex

Scooter's Drlg Serv
1215 Sklar Bldg
Shreveport La

A B See Drlg Co Inc
206 Petroleum Bldg
Abilene Tex

Paul Septer Drlg Co
521-22 Union Natl Bk Bldg
Wichita Kans

Seran & Howard Drlg Co
Box 110
Okemah Okla

SeRoBee Drlg Co Inc
521-22 Union Natl Bk Bldg
Wichita Kans

Severns Drlg Co Ltd
639 S Spring St Suite 1119
Los Angeles Calif

Service Drlg Co
515 Kennedy Bldg
Tulsa Okla

Harold Shappell Drlg Co
510 City Natl Bldg
Wichita Falls Tex

Sharp Drlg Co
Box 1271
Midland Tex

Sheets & Walton Drlg Co
Box 152
Breckenridge Tex

Shelley-Miller Drlg Co
205 Miller Bldg
Wichita Kans

Sherin Drlg Co Inc
1709 First Natl Bldg
Oklahoma City Okla

Shields Drlg Co Inc
Shields Bldg
Russell Kans

Shields Oil Producers
Shields Bldg
Russell Kans

Shoreline Drlg Co Inc
1203 Beck Bldg
Shreveport La

Shulman Bros
Box 191
Vandalia Ill

Signal Drlg Co
203 Mayo Bldg
Tulsa Okla

Signal Exploration Inc
203 Mayo Bldg
Tulsa Okla

Signal Oilfield Serv
203 Mayo Bldg
Tulsa Okla

Sikes-Burckhalter Drlg Co
300 Oil & Gas Bldg
Wichita Falls Tex

Joe Simpkins
6421 Easton Ave
St Louis 14 Mo

C J Simpson Drlg Co
Box 372
Indiana Pa

Skinner & McDougal Drlg Co
Box 8774
Oklahoma City Okla

Skipper Drlg Co
Box 511
Cushing Okla

Don Slape Drlg Co
Box 432
Olney Ill

Smallwood & Sons
3657 E Kiest Blvd
Dallas Tex

Smiley & Little Drlg Co
1635 SE 29th St
Oklahoma City Okla

Smith & Breyer
Suite 154 Meadows Bldg
Dallas 8 Tex

B B Smith Inc
Box 2876
Midland Tex

Darrell W Smith Co
Box 1105
Midland Tex

Ray Smith Drlg Co
Simons Bldg
Dallas Tex

L C Smitherman Drlg Co
Box 627
Augusta Kans

Sojourner Drlg Corp
Box 679
Abilene Tex

Sooner Drlg Co
412 Federal Natl Bk Bldg
Shawnee Okla

Southeastern Drlg Corp
901 Employers Ins Bldg
Dallas Tex

Southern Drlg Co
13th & San Fernando Rd
Newhall Calif

South State Drlg Corp
Mt Vernon Ind

South States Drlg Co
Box 147
Longview Tex

Southworth & Wood Inc
1021 San Jacinto Bldg
Houston Tex

J D Sprecher
Box 299
Casper Wyo

Orville Stanford Inc
Box 735
Santa Maria Calif

Stephens Oil & Gas Corp
1502 Main St Annex
Lubbock Tex

Stice Drlg Co
Box 678
Beeville Tex

Jack L Story
Box 1073
Dallas Tex

Stouder Drlg Co
208 SE Riverside Dr
Evansville Ind

Harold L Strader Drlg Co
3901 Mt Vernon
Houston 6 Tex

Strain Drlg Co
608 Patterson Bldg
Denver Colo

Strait Drlg Co
Box 90
Eldorado Kans

C W Strotman Drlg Co
620 S 30th St
Mattoon Ill

Stroube Drlg Co
Box 730
Corsicana Tex

Summit Drlg Corp
414 Atlas Life Bldg
Tulsa Okla

The Sun Drlg Co
417 S Hill St
Los Angeles 13 Calif

Sunnyland Contracting Co Inc
Box 388
Rayne La
Sutton Drlg Co
900 NE Military Dr
San Antonio Tex
Symons Drlg Co
Box 546
Houston Tex
Target Drlg Corp
710 Enterprise Bldg
Tulsa Okla
T & O Drlg Co
Box 461
Gainesville Tex
Taylor Expl Co Inc
2118 Welch Ave
Houston Tex
G S Taylor Drlg Co
Box 1097
Snyder Tex
W P Taylor Drlg Co
1429 Bk of the Southwest
Houston Tex
Temple Drlg Co Inc
320 Indiana Bk Bldg
Evansville Ind
Tennant Drlg Co
Rivoli Bldg
Blackwell Okla
Terminal Drlg & Prod Co
1240 Blinn Ave
Wilmington Calif
Texita Oil Co
812 Milam Bldg
San Antonio 5 Tex
Tex-Mex Drlg
1211 Fidelity Union Life Bldg
Dallas Tex
Thomas & Billups Drlg
809 Citizens Bk Bldg
Abilene Tex
A W Thompson Inc
Box 2524
Houston Tex
Thompson Drlg Co
Box 577
Comanche Okla
Thrasher Drlg Co
1602 Beck Bldg
Shreveport La
Tolson Drlg Co
213 Triangle Bldg
Pawhuska Okla
Trachta Drlg Co
Box 67
Muenster Tex
J C Trahan Drlg Contr Inc
1203 Beck Bldg
Shreveport La
Transit Corp
1516 Liberty Bk Bldg
Oklahoma City Okla
Trant Drlg Co
1201 Peoples Bk Bldg
Tyler Tex
Treasure State Drlg Co
Box 1712
Great Falls Mont
Triad Drlg Co
120 Featherston Bldg
Wichita Falls Tex
Trio Drlg Co
3013 Nussbaumer
Dallas 26 Tex
Triple E Drlg Co
223½ N Second
Seminole Okla
Tri-Service Drlg Co
Box 1785
Midland Tex
Triton Drlg Co Inc
Box 13221
Houston Tex
Troop Drlg Co
Box 145
St Elmo Ill
Troup & Suttles Inc
506 Diamond
Holdenville Okla

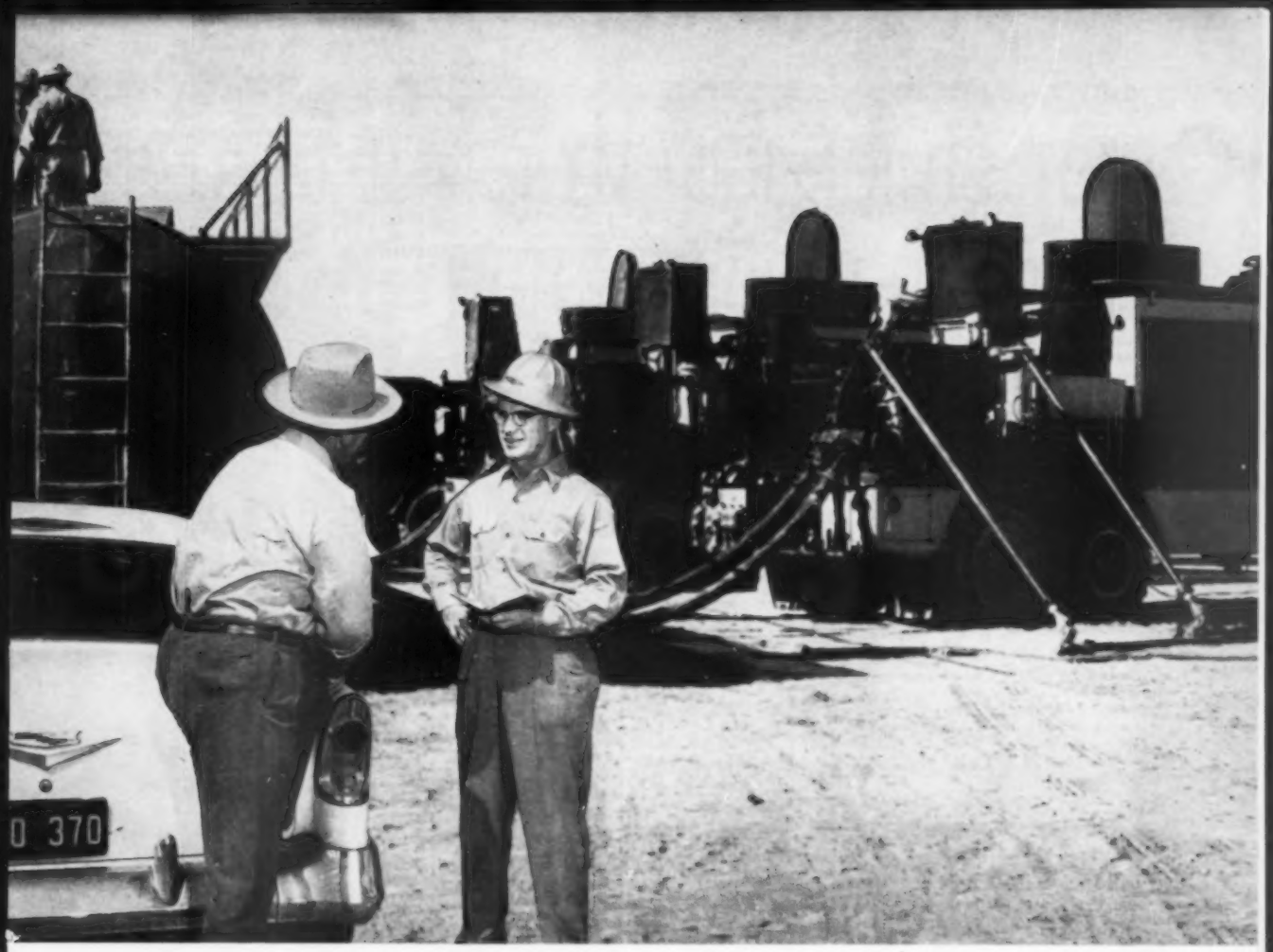
True Drlg Co
Drawer 1612
Casper Wyo
Tucker Drlg Co
Box 270
San Angelo Tex
Tullous Drlg Co
206 N Big Spring
Midland Tex
Goal Tullous & Co
206 N Big Spring
Midland Tex
Turnbull & Zoch Drlg Co
Box 2248
Corpus Christi Tex
Turner & West
Box 65
Stamford Tex
C D Turner Drlg Co
501 Permian Bldg
Big Spring Tex
Twinoak Drlg Co
210 S Morton
Okmulgee Okla
U & E Drlg Co
Box 323
Sullivan Ind
R W Uhl
1401 Washington Blvd
Bartlesville Okla
Union Rotary Corp
1104 N Mission St
Mt Pleasant Mich
Unit Drlg Co
Box 599
Bristow Okla
United Drlg Co
8750 Holloway Dr
Los Angeles 46 Calif
Urice Drlg Co
615 Ft Worth Club Bldg
Ft Worth Tex
V S & S Drlg Co
1004 Ridgley Bldg
Springfield Ill
V-T Drlg Co
711 Hulman Bldg
Evansville Ind
Varner-Neill Drlg Co
Box 492
Abilene Tex
W H Varner Drlg Co
Box 492
Abilene Tex
Veeder Supply & Dev Co
Box 201
Cherryvale Kans
Viersen & Cochran
Box 280
Okmulgee Okla
Viking Drlg Co
102 W Crockett St
San Antonio 5 Tex
W L B Drlg Co
6635 Chocolate Bayou Rd
Houston 21 Tex
Wade Drlg Co
Box 70
Cushing Okla
Wagner & Wyant Drlg Co Inc
414 Petroleum Bldg
Amarillo Tex
J H Wagner Drlg Co
Box 751
Eldorado Kans
Walters Drlg Co
510 Orpheum Bldg
Wichita Kans
Walters Drlg Co Inc
4114 McMillan
Dallas 6 Tex
Rusty Walters Drlg Co
Box 304
Bakersfield Calif
Walton Drlg Co
Box 241
Fairfield Ill
Ward Drlg Co
106 Oil & Gas Bldg
Wichita Falls Tex

Tommy Ward Drlg Co
1415 Liberty Bk Bldg
Oklahoma City Okla
Warton Drlg Co
Box 2807
Odessa Tex
Carnes W Weaver Drlg Co
326 Gulf Bldg
Houston Tex
C B Webster Drlg Co
609 San Jacinto Bldg
Houston Tex
Webster Drlg Co
424 S Cheyenne
Tulsa Okla
Dick Wegener Drlg Contr
1820 First Natl Bldg
Oklahoma City Okla
Wells Drlg Co
5382 Cherry Ave
Long Beach Calif
Art West Drlg Co
217 O'Michael Bldg
Odessa Tex
West Central Drlg Co
717 Citizens Bk Bldg
Abilene Tex
Western Drlg Co Inc
902 Lubbock Natl Bk Bldg
Lubbock Tex
Western Serv Drlg Co Inc
Box 1428
Odessa Tex
Chester H Westfall Drlg Co
1202 Hunt Bldg
Tulsa Okla
Wes-Tex Drlg Co
Box 2058
Abilene Tex
Westlund Drlg Co
Box 197
Midland Tex
Chet Whaley Well Serv Co Inc
6006 Milart St
Houston 21 Tex
Wheless Drlg Co
Box 368
Shreveport La
A W Williams Drlg Co Inc
411 Virginia St
Mobile Ala
Williams Drlg Co Inc
603 S Arkansas
Springhill La
Kidd Williams Drlg Corp
205 Kennedy Bldg
Tulsa Okla
Walter W Willis
813 Broadway
Mt Vernon Ill
Wilson Drlg Co Inc
Box 933
Jackson Miss
Wise Drlg Account
Box 297
Tyler Tex
Wolfe Drlg Co
Box 559
Tulsa Okla
Woodson Prod Co
412 Exposition
Dallas 26 Tex
Woolf & Magee Inc
Box 635
Tyler Tex
Wright Clark & Senkel Inc
Box 267
Graham Tex
S P Yates Drlg Co
311 Carper Bldg
Artesia N Mex
Marshall R Young Drlg Co
Box 712
Brookhaven Miss
Zapata Off-Shore Co
2218 City Natl Bk Bldg
Houston Tex
Zephyr Drlg Corp
1111 First Natl Bldg
Tulsa Okla

U. S. Contract ROTARY Drilling Rigs

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
ALABAMA						
Mobile County						
Index Drlg Co	2-B	LPG	250	Beth S-45	250	6,000/3½"
Jett Drlg Co Inc	1	dsl	—	—	700	9,000
Justiss-Mears Oil Co Inc	7	dsl	700	Emsco J-750	1000	11,500
ARKANSAS						
Columbia County						
E G Bradham	1	LPG-gas	—	Crdwll S	180	10,000
McAlester Fuel Co	—	btne-gas	—	Emsco GC-500	820	11,000
	—	dsl	—	Crdwll Trlrg	275	5,500
Penrod Drlg Co	16	gas-btne	—	—	1500	15,000
Franklin County						
Wolfe Drlg Co	3	gas-btne	536	Natl 50	536	7,500
Lafayette County						
Milton Crow Inc	5	gas	600	Brwstr N-7	—	7,500
H & S Drlg Co	2	gas-btne	1000	Brwstr N-95	1000	14,000
Hilburn Industries Inc	2	gas	550	Wisn	—	10,000
	4	gas	550	Wisn	—	10,000
Johnson Drlg & Serv Co	2	dsl	225	Beth Twstr	300	6,500
Montgomery Drlg Co	1	gas-btne	700	Emsco GA-500	600	9,500
	2	gas-btne	415	Brwstr N-55	—	7,500
Logan County						
Parker Drlg Co	30	gas	—	Natl L-50	700	9,000
Viersen & Cochran	10	gas	325	Natl 50	450	8,800
Miller County						
Milton Crow Inc	6	dsl	—	Brwstr N-4	—	5,500
Mercury Drlg Corp	1	gas	200	Ideco H-20	200	3,500
Ouachita County						
Gary Drlg Co	2	btne	145	—	200	4,000
Pulaski County						
Walters Drlg Co Inc	13	gas	200	Mayhew 1000	200	600/2⅛"
Saline County						
Walters Drlg Co Inc	3	gas	130	Mayhew	130	1,000
	4	gas	130	Mayhew 1000	130	600/2⅛"
	5	gas	150	Mayhew 1000	150	600/2⅛"
	7	gas	175	Mayhew 1000	175	900/2⅛"
	8	gas	220	Mayhew 1000	220	600/2⅛"
	9	gaso	130	Mayhew 1000	130	800/2⅛"
	11	gas	150	Mayhew 1000	150	600/2⅛"
Union County						
Alan Drlg Co	3	gas	275	Wisn Mogul	145	3,500
E G Bradham	2	LPG-gas	—	Brwstr N-4	145	10,000
Kern Drlg Co Inc	2	gas	600	Emsco GB-350	500	7,500
CALIFORNIA						
Fresno County						
B J & M Drlg Co Ltd	2	gas	450	Emsco GA-500	450	7,500
Camay Drlg Co	8	dsl	850	Emsco A-800	1200	12,000
Drlg & Prod Co	1	dsl	325	Crdwll	420	6,000
Armstrong Fowler Inc	2	dsl	200	Natl T-12	250	2,500
Miller & York	1	dsl	275	Frnks Clipper	225	3,500
	F	dsl	735	Emsco GA-500	550	8,000
Gene Reid Drlg Inc	2	dsl	680	Ideco 525	600	7,000
Rocky Mountain Drlg Co	13	gas	1200	Emsco J-1250	1500	20,000
Rusty Walters Drlg Co	1	dsl	300	Wisn Mogul	300	7,000/4"
Kern County						
B & B Drlg Co	1	dsl	278	Gen Mach	250	2,750
	2	btne	90	—	175	2,000
B J & M Drlg Co Ltd	3	gas	450	Natl 50	775	8,500
	4	dsl	600	Natl 50	600	8,500
Barnes Core Drlg Co	D-6	dsl	225	Custom	225	4,000/3½"
Camay Drlg Co	1	gas	1075	Emsco J-1000	1000	12,000
Casner & Bentz	1	gas-btne	445	Emsco GA-250	195	4,500
Coastal Drlg Co	2	dsl	800	Emsco J-750	1320	11,000
	4	gas	1000	Emsco GB-800	1050	12,000
H Davis & R H Thompson Co	1	dsl	300	Emsco G-300	300	6,000
	2	dsl	300	Emsco GA-250-T	300	6,000
Douglas Drlg Co	1	btne	125	Emsco	125	2,500
Drlg & Prod Co	2	dsl-gas-gaso	325	Crdwll O	432	6,000
Enterprise Oil Co	3	dsl	300	Wisn Torcair	150	4,000/3"
	4	dsl-LPG	300	Howard-Turner	220	2,800
Green & Dreblow Drlg Co	—	dsl	600	Wisn Giant	600	7,500
John S Hagestad Drlg Co	4	dsl	680	Ideco H-525	440	7,500
Clyde Hall Drlg Co Inc	5	gas-btne	1000	Emsco GB-800	1000	12,000
Hylton Drlg Co	2	btne	85	Wisn Sr	85	2,500
	4	dsl	100	Gen Mach	105	3,500
Ivy Drlg Co	1	dsl	185	Hopper IG	185	1,500
	2	btne	185	Hopper GF	185	3,000
K L Kellogg & Sons	25	dsl	1480	Natl 75	1480	9,500
L & F Drlg Co	1	gas	300	Emsco GB-250	—	5,000
	2	dsl	500	Emsco GB-250	—	5,000
	3	gas-dsl	900	Emsco 450	—	8,000
Loffland Bros Co	131	dsl	1000	—	1000	12,000
Miller & York	A	dsl	825	Emsco GC-500	825	10,000
	G	dsl	275	Emsco G-36	275	5,000
	H	dsl	275	Emsco GA-250	275	5,000
	J-11	dsl	210	Hopper GTA	210	3,500
Myers Drlg Serv	9	dsl	165	Crdwll	165	3,000/3½"
Newton Drlg Co	1	dsl	300	Ideco H-30	—	4,000
	4-40	dsl	320	Emsco GB-250	—	6,000
Gene Reid Drlg Inc	1-A	dsl	680	Natl 55	680	9,000
	4	dsl	680	Ideco H-40	340	5,000
	6	dsl	340	Unit U-10	340	5,000
	10	dsl	340	Wisn Mogul	340	4,000
Rocky Mountain Drlg Co	10	gas	1200	Emsco J-1000	1550	15,000
Santa Fe Drlg Co	11	dsl	300	Wgnr-Mrhse	300	6,000
Santa Maria Drlg Corp	5	gas	750	Wisn Atlas	900	10,000
Kings County						
K L Kellogg & Sons	31	gas	1580	Natl 125	1050	16,000
Los Angeles County						
Camay Drlg Co	4	gas	555	Emsco 500	500	7,500
	5	gas	535	Natl 50	500	7,000
	6	gas	605	Natl 50	500	7,000
	7	gas	535	Emsco G-300	300	6,000
F E Gober Drlg Co	2	gas	816	Natl 50-A	450	7,500
Fred Johnson Drlg Co	—	gas-gaso	1050	Emsco J-1000	1050	12,000
	—	gas-gaso	1050	Wisn Titan	700	10,000
	—	gas-gaso	800	Emsco G-450	700	6,500
	—	gas-gaso	1400	Wisn Titan	1050	10,000
Kee & Simpson Drlg Co	2	gas-btne	—	Beth 58	420	7,000
K L Kellogg & Sons	18	gas	925	Natl 50	650	7,000
	27	gas	2000	Natl 100	1050	13,000
	28	dsl	1350	Natl 100	1100	13,000
Loffland Bros Co	132	gas	870	—	900	10,000
	134	gas	800	—	900	10,000
	141	gas	1000	—	1500	18,000
Macrate Prod Co	2	dsl	175	Ideco HD-30	190	3,500
	7	gas	300	Wgnr Mrhse	250	4,000
Lottie B McFann Drlg Co	1	gas-btne	550	Natl 50	450	7,000
Rocket Drlg Co	1	gas-btne-prop	555	Emsco G-300	350	4,500
Rocky Mountain Drlg Co	6	gas	1200	Emsco J-1000	1550	15,000
	12	gas	1480	Natl 125	1850	20,000
	14	gas	1200	Emsco J-1250	1500	20,000
Santa Fe Drlg Co	28	gas	1200	Natl 80-B	1350	12,000
Santa Maria Drlg Corp	1	gas	850	Wisn Titan	1200	10,000
Southern Drlg Co	1	gas	225	Crdwll H	145	2,500
The Sun Drlg Co	1	dsl	950	Natl 110	1425	12,000
	2	gas	1400	Natl 125	1250	15,000
	3	elec	750	Natl 110	1100	15,000
	4	elec	750	Natl 110	1100	15,000
Terminal Drlg & Prod Co	2	dsl	—	Natl 50A	700	8,500
	3	dsl	—	Wisn Mogul	350	5,000
	4	gas	—	Ideco H-40	460	6,000
	14	gas	—	Ideco H-25	105	2,000
	17	dsl	—	Wisn Mogul	350	5,000
Wells Drlg Co	2	dsl	325	Wldrp Blitz 622	350	4,500
Monterey County						
Armstrong Fowler, Inc	1	dsl	610	Natl 50-CA	450	7,500
Newton Drlg Co	2	dsl	320	Ideco H-40	—	5,000
Orange County						
Kee & Simpson Drlg Co	1	gas-btne	—	Natl 50	380	6,500
K L Kellogg & Sons	19	dsl	1200	Natl 75	790	9,500
	23	gas	2090	Natl 75	790	9,500
Santa Fe Drlg Co	23	dsl	300	Ideco H-40	300	6,000
	25	gas	1050	Natl 55	900	10,000
Terminal Drlg & Prod Co	1	gas	—	Natl 50	440	7,000
Wells Drlg Co	1	dsl	650	Unit U-10	350	5,000
Placer County						
John S Hagestad Drlg Co	2	dsl	540	Ideco H30-D	340	4,500
Sacramento County						
B J & M Drlg Co Ltd	1	dsl	600	Unit 35-L	400	7,000
San Benito County						
John S Hagestad Drlg Co	1	dsl	570	Emsco GB-350	400	7,000
	3	dsl	625	Emsco GB-350	400	7,000
Miller & York	C	dsl	550	Emsco GB-350	425	6,500
Petrolex Inc	1	dsl	280	Hopper Blitz	150	5,000/3½"
San Bernardino California						
Santa Rosa Drlg Co	1	prop-gas	155	—	130	2,000
San Joaquin County						
Gene Reid Drlg Inc	8	dsl	340	Hopper GTA 6110	300	6,000/2⅞"
Rusty Walters Drlg Co	1	dsl	300	Cooper D-50	300	6,500/4"
San Luis Obispo County						
Barnes Core Drlg Co	D-10	dsl	450	Custom	450	5,500/3½"

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Green & Heiser Drlg Co	1	dsl	835	"Oilwell" 66	550	9,500
Santa Barbara County						
Casner & Bentz	2	gas-btne	800	Emsco GA-450	550	8,000
Santa Maria Drlg Corp	2	gas	400	Wlsn Giant	600	5,000
	4	gas	500	Wlsn Giant	900	7,500
Orville Stanford Inc	1	gas	650	Wlsn Giant	650	7,500
	2	dsl	734	Natl 50	750	8,000
	3	dsl	1095	Beth M-58	1100	12,000
Sonoma County						
Barnes Core Drlg Co	D-11	dsl	225	Custom	225	3,000/3½"
Ventura County						
Camay Drlg Co	2	gas	1080	Wlsn Titan	1000	12,000
	3	gas	855	Natl 75	650	9,000
	9	gas	1900	Natl 130	1900	16,000
Drlg & Expl Co of Delaware Inc	20	gas-gaso	1200	Natl 100	900	13,500
	28	gas-gaso	800	Natl 50A	750	10,000
	29	gas-gaso	1500	Natl 34-10	1200	18,000
	31	gas-gaso	1500	Natl 130	1200	18,000
K L Kellogg & Sons	7	gas	2240	Natl 100	1050	13,000
	29	gas	1370	Natl 75	700	9,500
	32	gas	1400	Natl 75	1050	9,500
	33	gas	1750	Emsco GB-800	1050	12,000
	34	gas	2475	Natl 125	2475	16,000
	35	dsl	1800	Natl 130	1800	18,000
	36	gas	2475	Natl 125	2475	16,000
Knight Drlg Co	1	dsl	1020	Unit U-35D	340	5,500
Loffland Bros Co	2	gas	1350	—	1350	20,000
	6	gas	1500	—	1400	16,000
	9	gas	1500	—	1400	16,000
	19	gas	1000	—	900	10,000
	111	gas	1000	—	1040	11,000
Rocky Mountain Drlg Co	1	gas	1200	Natl 75	900	11,000
	2	gas	1200	Natl 75	900	11,000
	3	gas	1200	Natl 100	900	14,000
	4	gas	1400	"Oilwell" 96	1750	20,000
	5	gas-dsl	1480	"Oilwell" 96	1850	20,000
	7	gas	1200	Natl 100	1110	15,000
	8	gas	1400	Natl 125	1750	20,000
	9	gas	1200	Natl 125	1500	20,000
	15	gas	1200	Emsco J-750	900	11,000
Santa Fe Drlg Co	3	gas	900	Emsco G-500	440	7,500
	9	gas	1050	Wlsn Titan	900	10,000
	26	gas	1200	Wlsn Titan	900	10,000
Santa Maria Drlg Corp	3	gas	850	Wlsn Titan	1200	10,000
Severns Drlg Co	1	gas	1350	Natl 100	1350	11,000
Terminal Drlg & Prod Co	5	dsl	—	Ideco H-40	350	5,000
	6	dsl	—	Emsco GC-500	440	7,000
	18	dsl	—	Ideco H-525	840	8,000
United Drlg Co	1	gas	380	Emsco EDA	450	6,000
Yolo County						
Coastal Drlg Co	1	dsl	1500	Emsco J-1250	1920	16,000
COLORADO						
Adams County						
B F Allison Drlg Co	4	gas-btne	900	Brwstr N-75	900	11,000
Herndon Drlg Co	8	gas	600	Natl 50-A	750	10,500
Delta County						
Signal Drlg Co	2	dsl	—	Natl 80	900	14,000
Denver County						
Taylor Expl Co Inc	2	gaso	—	Failing	—	1,500
	3	btne	—	Failing	—	1,500
Fremont County						
Branyan Drlg Co	2	dsl	700	Beth	700	9,000
Grand County						
B F Allison Drlg Co	2	gas-btne	675	Unit U-15	675	8,500
Jackson County						
Falcon Seaboard Drlg Co	18	dsl	700	Whind B-85	—	10,000
La Plata County						
The Cortez Drlg Co	1	gas	300	Natl T-32	320	6,000
Exploration Drlg Co	10	gas	505	Unit U-15	400	8,000
Kent Drlg Co	1	dsl-gas	—	Natl 75 CE	1050	10,500
Moran Bros Inc	9	gas	800	"Oilwell" 66	750	10,000
	10	gas	550	Emsco GA-350	650	8,500
George W Riley Inc	22	gas-gaso	300	Crdwll Trlr	—	5,500
Urice Drlg Co	1	gas-btne	700	Emsco GA-500	700	8,500
Larimer County						
Mountain States Drlg Co Inc	17	dsl	540	Natl T-32	—	6,000
Logan County						
Brack Drlg Co Inc (Colo)	5	dsl	—	—	254	5,500
Don Johnston Drlg Co	4	gas-btne	650	Natl 50	650	7,500
Lewis Bros Inc	2	dsl	376	Unit U-15	476	6,500
Mesa County						
Carmack Drlg Co	5	gas	400	Natl T-32	320	6,000
Mac's Drlg Co	C	dsl	365	Crdwll AH	200	4,000
Moffat County						
Carmack Drlg Co	1	dsl	680	Natl 50-A	450	8,000
Falcon Seaboard Drlg Co	25	dsl	225	Beth Twister	—	6,500
Lohmann-Johnson Drlg Co Inc	4	dsl	300	Unit U-15	440	5,500
Nye & Snell Drlg Co	3	dsl	500	Wlsn Atlas	800	11,000
	4	dsl	320	Unit U-15	320	6,000
Rowan Drlg Co Inc	24	gas-btne	504	Natl 50	1077	8,500
Montezuma County						
Exploration Drlg Co	11	gas	380	Beth S-60	480	8,000
Great Western Drlg Co	31	gas-gaso	—	—	840	9,000
Rocket Drlg Co Inc (Kans)	2	dsl	—	—	520	7,500
Montrose County						
Dyer Drlg Co	2	gas-gaso	325	"Oilwell" 64-B	480	7,000
Otero County						
Herndon Drlg Co	3	gas	600	Natl 50	750	8,000
Rio Blanco County						
A O Bullock Drlg Co	3	gas	370	Beth Twister	—	7,500
Delta Drlg Co	25	gas-btne	1520	Emsco J-1250	1250	15,000
Loffland Bros Co	13	dsl	1000	—	1200	14,000
George Noland Drlg Co Inc	8	gas-btne	—	Emsco GA-500	730	8,500
Signal Drlg Co	4	gas	300	Ideco H-25	300	4,200
Washington County						
B F Allison Drlg Co	1	gas-btne	450	Natl T-32	400	5,500
	5	gas-btne	450	Frnks 137	390	5,500
Garvey Drlg Co	12	dsl	300	Wlsn Giant	320	6,000/3½"
Weld County						
Baird & Pfeifer Drlg Co	1	dsl	450	Unit U-15	—	9,500
	2	gas	300	Unit U-15	—	7,500
Exeter Drlg Co	2	btne	320	Emsco GA-250	250	6,000/4"
Loffland Bros Co	8	gas	1000	—	1200	16,000
	94	dsl	970	—	1275	11,000
FLORIDA						
Palm Beach County						
Dorris Ballew Inc	3	dsl	760	Wlsn Titan	1900	15,000
ILLINOIS						
Bond County						
Claypool Drlg Co	2	btne	185	Natl N-40	185	4,500
Shulman Bros	2	dsl	330	Crdwll L	—	3,500
Christian County						
Joe Simpkins	1	dsl	—	Emsco GA-160-T	500	3,500
V S & S Drlg Co	2	dsl	—	Wlsn	—	2,400
Clay County						
Herndon Drlg Co	7	gas	409	Natl T-32	559	4,500
Don Slape Drlg Co	2	dsl	240	Unit U-34	230	4,500
Clinton County						
C E Brehn	2	dsl	240	Brwstr N-45	—	7,000
D B Lesh Drlg Co	1	dsl	200	—	—	4,000
M Mazzarino	—	gas-gaso	200	Frnks 2000	200	2,500
Perrine & Perrine Drlg Contr	1	btne	—	Crdwll S	185	4,000
Coles County						
U & E Drlg Co	—	dsl	500	Frnks 4500	400	5,000
Douglas County						
W L Dillier	3	gas	—	Failing 2500	130	2,000
Edwards County						
Calvert Drlg Inc	8	dsl	260	Ideco H-30	190	4,500
The Noah Petroleum Co	1	dsl	300	Brwstr N-4	300	5,500
Fayette County						
Troop Drlg Co	1	gas-gaso	—	Natl T-20	200	4,500
Gallatin County						
Calvert Drlg Inc	16	dsl	260	Ideco H-35	190	5,000
Herndon Drlg Co	9	gas	240	Natl T-25	390	4,000
Hamilton County						
Calvert Drlg Inc	11	dsl	260	Natl T-32	190	5,000
Jasper County						
Woody Jones Drlg Co	1	dsl	240	Unit U-34	230	4,500
Don Slape Drlg Co	4	dsl	300	Brwstr N-4	245	4,500
Jefferson County						
Claypool Drlg Co	1	btne	225	Natl T-20	185	4,500
Ted Lindsay	2	dsl	220	Natl T-16	220	5,000
Paco Petroleum Corp	3	dsl	320	Unit U-35	320	7,000
Petro Drlg Co Inc	1	dsl	450	Brwstr N-4	300	6,500
Walter W Willis	1	dsl	278	Beth 430-S	200	4,500
Kankakee County						
D B Lesh Drlg Co	2	dsl	320	—	—	5,500
Lawrence County						
W L Dillier	2	gas	—	Failing 2500	130	2,000
Hoagland Drlg Co Inc	1	btne	145	Frnks 2000	—	2,000/2½"
Houchins Drlg Co	1	gas	185	Natl T-12	185	4,500
Walton Drlg Co	1	gas	—	Failing 2500	—	2,000/3½"
	2	gas	—	Failing 2500	—	2,000/3½"
Marion County						
Graham Powell	1	dsl	—	Natl 50	—	6,000



A Dowell engineer will tell you the advantages of Allison aircraft-powered pumpers.

Make fracturing treatments more effective ....with DOWELL auxiliary services

Fracturing treatments to improve oil or gas production often call for more than just sand and a carrying fluid. Special addition agents and auxiliary services can mean the difference between success or failure.

Dowell engineers have at their disposal a wide variety of fracturing aids to solve specific well problems. Here are four of the more important Dowell products and services that help you get even better results from fracturing.

MUD ACID* is a mixture of hydrochloric acid and hydrofluoric acids. It dissolves clay minerals and destroys the swelling and colloidal properties of bentonitic materials. As a spearhead, Mud Acid increases fracturing effectiveness by cleaning the formation face.

F. L. A.* (Fluid Loss Additive) is designed to lower the fluid loss of fracturing fluids. F. L. A. helps provide longer fractures and deeper penetration of sand. There are several kinds of F. L. A. to meet various well conditions.

FIXAFRAC* uses a temporary plugging material consisting of solids suspended in a fluid. These solids liquify after a short time and return to the well bore. Fixafrac is used between treatment stages to seal initial fractures or permeability, allowing new fractures to be formed in other sections of the pay zone.

FREFLO* is a mixture of chemicals that acts in three ways to prevent or destroy water block. It reduces surface tension, it partially destroys interfacial tension between water and oil, and it breaks emulsions. In fracturing treatments, Freflo is added to the breakdown and flush oil to prevent emulsions.

For more information or service, call any of the 165 Dowell offices in the United States and Canada; in Venezuela, contact United Oilwell Service. Or write to Dowell Incorporated, Tulsa 1, Oklahoma.

*Trademark of Dowell Incorporated

Services for the oil industry

DOWELL

A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Montgomery County						
Ted Lindsay	1	dsl	160	Ideco H-30	160	4,000
Richland County						
D B Lesh Drlg Co	4	gas	450	—	—	7,000
Saline County						
T M Pruett Drlg Contr	1	dsl	—	Unit U-15	300	8,000
Don Slape Drlg Co	5	btne	360	Natl T-12	260	4,500
V S & S Drlg Co	4	dsl	—	Beth	—	4,200
Shelby County						
W L Dillier	1	gas	—	Natl T-12	212	3,000
Tazewell County						
Don Slape Drlg Co	3	dsl	260	"Oilwell" 64-B	230	5,500
Wabash County						
U & E Drlg Co	—	dsl	400	Crdwll S	200	3,500
Washington County						
Graham Powell	2	dsl	—	Natl T-12	—	3,200
Wayne County						
Central Drlg Co (Fairfield Ill)	4	dsl	—	—	—	4,000
	6	btne	260	—	—	4,000
B L Rucker Drlg Co	1	dsl	318	Beth 45-E	—	5,000
Joe Simpkins	3	dsl	500	Natl T-20	500	5,000
Walter W Willis	2	dsl	256	Natl T-12	237	4,500
White County						
C E Brehn	1	dsl	240	Brwstr N-45	—	7,000
Ferbanta Drlg Co	1	gas	250	Crdwll S-140	200	4,500
	1S	gas	250	Crdwll S-140	250	4,500
Harris Drlg Co	2	btne	276	Natl 40	172	4,000
	3	dsl	285	Natl 50	285	8,500
Herndon Drlg Co	5	gas	375	Brwstr N-4	375	4,500
Ted Lindsay	3	dsl	220	Crdwll S	160	4,500
Lohmann-Johnson Drlg Co Inc	7	gas	300	Crdwll S	440	4,500
Paco Petroleum Corp	1	dsl	320	Natl T-32	320	6,000
Shulman Bros	1	dsl	330	Crdwll S-350	—	5,500
Don Slape Drlg Co	1	dsl	260	"Oilwell" 64-A	230	5,000
INDIANA						
Gibson County						
Big Seven Drlg Co	1	dsl	300	Emsco GB	300	4,500
Central Drlg Co	1	gas	225	Natl 40	185	4,500
	1	dsl	225	Unit U-34	225	4,000
W L Dillier	4	gas	—	Failing 2500	130	2,000
Harris Drlg Co	1	btne	195	Crdwll S	172	4,000
Highland Oil	2	—	—	B Erie 28L	—	2,000
Lohmann-Johnson Drlg Co Inc	6	gas	300	Crdwll S	440	4,500
Pike County						
Henry Gwaltney Drlg Co	1	dsl	200	Natl T-12	165	3,000
Posey County						
Eastern Drlg Inc	1	dsl	266	Natl T-20	—	5,000
Kendall-Davis Drlg Co Inc	1	dsl	300	Wisn Mogul	300	4,000
Paco Petroleum Corp	2	btne	200	Wisn Mogul	165	4,000
South State Drlg Corp	1	dsl	100	Crdwll	110	3,100/2⅛"
Vanderburgh County						
Kendall-Davis Drlg Co Inc	2	dsl	300	Crdwll S	300	4,000
IOWA						
Dallas County						
Kirby Oil Ind	—	gas-gaso	—	Mayhew 3000	145	3,000
	—	dsl	—	Unit U-34	275	4,500
KANSAS						
Barber County						
Garvey Drlg Co	10	dsl	175	Wisn Giant	296	5,000
Graham-Michaelis Drlg Co	6	dsl	275	Beth Breeze	175	4,000
Lewis Drlg Co	2	dsl	550	Unit U-15	550	6,000
Patton Drlg Co Inc	2	dsl	—	Natl 50	350	5,500
Prime Drlg Co	5	dsl	300	Natl T-20	300	5,000
Barton County						
Bennett &Roberts Drlg Co	1	dsl	250	Emsco 250	250	5,000
Gabbert-Jones Drlg Co	1	gas	320	Emsco 300	300	5,000
Garvey Drlg Co	8	dsl	175	Wisn Giant	296	5,000
	11	dsl	175	Wisn Giant	296	5,000
Harms-Burt Drlg Co	2	dsl	160	Emsco 350	350	6,500
Lewis Drlg Co	3	dsl	260	Crdwll	260	5,500
Musgrove Petroleum Corp	8	dsl	230	Natl 50	—	5,000
Reserve Drlg Co Inc (Kans)	3	dsl	320	Natl T-32	320	5,500
Butler County						
Rex & Morris Drlg Co	1	dsl	260	Natl T-25	260	4,000
Clark County						
Patton Drlg Co Inc	1	gas	—	Natl 50	450	6,500
Cowley County						
Badger Drillers Inc	1	dsl	280	Natl T-32	320	6,500
L C Smitherman Drlg Co	3	dsl	265	Brwstr N-4	265	5,500
Decatur County						
Lohmann-Johnson Drlg Co Inc	3	gas	300	Natl 50	450	5,500
Ellis County						
Garvey Drlg Co	14	dsl	175	Wisn Giant	296	5,000
Isern Drlg Co	1	dsl	450	Unit U-15	450	7,000
A L Jackson Drlg Co	1	dsl	285	Unit U-15	285	6,000
Lewis Drlg Co	1	dsl	260	Crdwll	225	4,500
Mallonee Drlg Co Inc	1	btne	220	Beth Breeze	200	4,500
Powell Drlg Co	1	dsl	—	Emsco GB-350	350	6,500
Prime Drlg Co	3	dsl	275	Unit U-34	285	4,500
Transit Corp	4	dsl	250	Emsco	—	4,500
Walters Drlg Co	1	gas	—	Natl 50	500	5,500
Finney County						
Garvey Drlg Co	15	dsl	175	Wisn Giant	296	5,000
Graham County						
Empire Drlg Co (Kans)	2	dsl	300	Natl T-32	300	5,000
Garvey Drlg Co	3	dsl	175	Unit U-15	296	5,000
Harms-Burt Drlg Co	1	dsl	150	Emsco 250	250	5,000
Herndon Drlg Co	10	gas	409	"Oilwell" 64-A	559	4,500
Transit Corp	2	dsl	230	Emsco	—	4,500
Greeley County						
Edgar Davis Drlg Co	11	gas-btne	325	Unit U-15	600	7,500
Greenwood County						
Greenwood Petroleum Mgt Inc	1	dsl	—	Frnks 5000	—	—
Hamilton County						
Lewis Drlg Co	4	dsl	450	Crdwll	450	6,000
Harper County						
Harry Bass Drlg Co	114	gas	570	Crdwll	570	7,000
Garvey Drlg Co	5	dsl	175	Unit U-15	296	5,000
Rupp-Ferguson Oil Co	1	dsl	350	Ideco H-35	350	5,000
Harvey County						
Rocket Drlg Co Inc (Kans)	1	dsl	—	—	520	7,500
Hodgeman County						
R W Rine Drlg Co	1	gas-btne	620	Unit U-15	600	7,500
Kingman County						
Beardmore Drlg Co	1	dsl	300	Natl 50	450	6,000
D & M Drlg Co Inc	2	gas-btne	225	Brwstr N-4	280	5,000
Graham-Michaelis Drlg Co	8	dsl	400	Crdwll D	400	5,000
Kiowa County						
D & M Drlg Co Inc	3	dsl	600	Unit U-15	600	7,500
Falcon Seaboard Drlg Co	20	gas-btne	425	Unit U-15	425	8,500
	26	dsl	225	Beth Twister	—	6,500
Gabbert-Jones Drlg Co	3	gas	320	Emsco 300	300	5,000
Graham-Michaelis Drlg Co	4	dsl	500	Unit U-15	500	7,000
Lincoln County						
Donald T Ingling	4	dsl	225	Brwstr N-4	225	5,500
McPherson County						
Greenland Drlg Co	1	dsl	190	Emsco 160	190	4,500
Mallard Drlg Co	1	dsl	285	Emsco G-300	285	4,000
Meade County						
Capitt Drlg Inc	3	dsl	325	Beth C-50	500	8,500
D & M Drlg Co Inc	1	gas-btne	550	Natl 50	550	7,500
Gabbert-Jones Drlg Co	2	gas	450	Emsco 350	450	7,000
Garvey Drlg Co	21	dsl	500	Unit U-15	640	8,500
Montgomery County						
Veeder Supply & Dev Co	D	dsl	280	Natl T-25	300	4,500
	E	dsl	270	Frnks 658	270	3,500
Morton County						
Garvey Drlg Co	9	dsl	175	Wisn Giant	296	5,000
	18	dsl	300	Wisn Roadair	450	7,000/3½"
Graham-Michaelis Drlg Co	1	dsl	275	Beth Twister	500	6,500
	3	dsl	300	Crdwll S	175	5,000
Holm Drlg Co	4	dsl	560	Wisn Giant	300	5,500
	5	dsl	300	"Oilwell" 82 T	300	5,500
Rice County						
Beardmore Drlg Co	2	dsl	300	Emsco 300	320	4,000
Bennett & Roberts Drlg Co	3	dsl	250	Emsco 250	250	5,000
Rush County						
Bennett & Roberts Drlg Co	2	dsl	250	Emsco 250	250	6,000/3½"
Prime Drlg Co	2	dsl	300	Beth S-45	300	5,000
Russell County						
Shields Drlg Co Inc	2	dsl	300	Beth C-50	300	8,000
Sedgwick County						
Herndon Drlg Co	1	gas	409	"Oilwell" 64-B	559	6,000
Peak Drlg Co Inc	12	gas-LPG	220	Natl T-12	220	4,000
Stafford County						
Buick Drlg Co	2	dsl	300	Wilson	—	4,500
Garvey Drlg Co	22	dsl	300	Wisn Mogul 82	450	7,000/3½"
Transit Corp	3	dsl	230	Emsco	—	4,500
Stanton County						
Garvey Drlg Co	20	dsl	300	Wisn Mogul 82	450	7,000/3½"
Stevens County						
Moran Bros Inc	14	dsl	275	Natl T-12	300	4,500
Sumner County						
Capitt Drlg Inc	2	dsl	300	Beth S-45	285	5,000
Falcon Seaboard Drlg Co	27	gas-btne	185	Unit U-34	—	5,000
Herndon Drlg Co	6	gas	409	Natl T-32	559	6,000

REED FIELD-PROVEN TOOL JOINTS FOR LIGHT WEIGHT DRILL PIPE

If your operation requires light weight drill pipe, look to the leader for the right tool joint

REED
Super Shrink-Grip
SSG-R TOOL JOINT
FOR LIGHT WEIGHT DRILL PIPE

a — The shrink-grip "safety area" supports the drill pipe beyond the last engaged thread . . . and seals against leakage.

b — Entire thread length protected by a seal at each end.

c — New SSG-R design assures maximum pipe end thickness maintained to give greatest area to shoulder seal. (Exclusive Reed feature.)

REED has been the pioneer in designing and developing tool joints for use on light weight drill pipe. In fact, Reed has supplied most of the tool joints for light weight drill pipe now in use.

Reed has developed and field-proved special design light weight tool joints. In addition, Reed tool joints for light weight drill pipe can be furnished with API thread working connections. These tool joints can be manufactured with the same O.D. dimensions, box and pin length, tong space, and hard facing if desired, as Reed tool joints for conventional drill pipe. You may order Reed tool joints specifically designed for use with light weight drill pipe in both Super Shrink-Grip and Flash Welded types.

A special feature of Reed's Super Shrink-Grip tool joint permits a thicker pipe end for the shoulder seal (see illustration). This exclusive Reed design assures a perfect shoulder seal, even though there may be some eccentricity in the thinner light weight drill pipe end.

Reed alone offers a tool joint that's right for every drilling need. If you want more facts about tool joints for *light weight* drill pipe, ask the leader . . . ask the Reed Man!

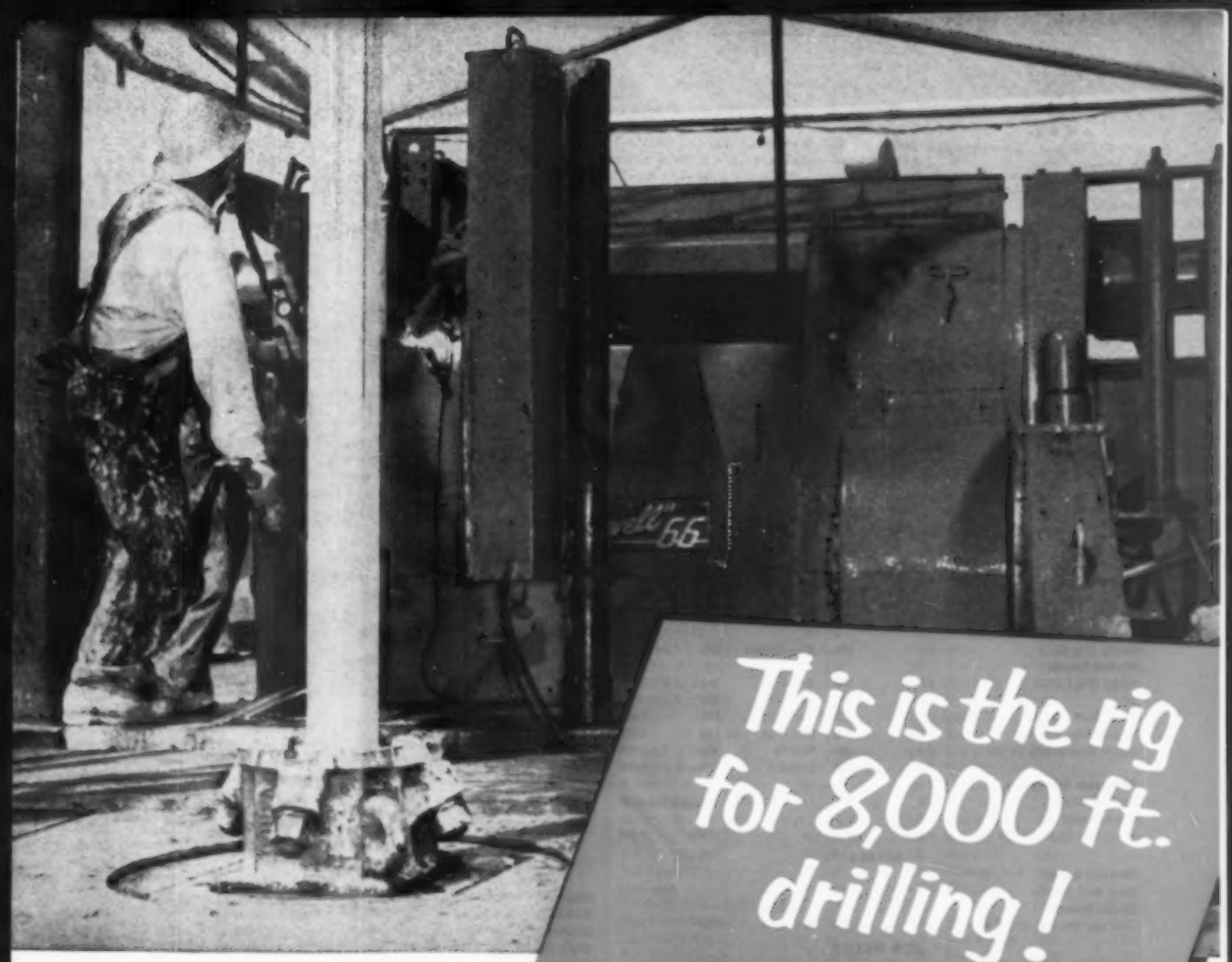
REED ROLLER BIT COMPANY
Houston 1, Texas

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Pickrell Drlg Co	1	dsl	450	Unit U-15	450	6,500
Trego County						
Shelley-Miller Drlg Co	1	dsl	—	Wisn	—	5,500
Wichita County						
Musgrove Petroleum Corp	2	dsl	495	Emsco 350	—	7,000
KENTUCKY						
Daviess County						
Hupp & Hume	2	dsl	117	Natl 40	300	3,000
V-T Drlg Co	1	dsl	220	Crdwll H	160	4,000
Henderson County						
Eakle & Holder Drlg Co	1	dsl	200	Brwstr N-4	—	5,500
Temple Drlg Co Inc	2	dsl	300	Crdwll S	440	4,500
Hopkins County						
Stouder Drlg Co	1	LPG	200	Natl 40	160	4,500
Lee County						
Overby Drlg Co Inc	2	dsl-btne	250	Mayhew 2000	—	2,500
McLean County						
Henry Gwaltney Drlg Co	2	gas-prop	200	Crdwll	165	3,000
Hupp & Hume	1	dsl	225	Natl 40	300	4,500
Union County						
Advance Drlg Co	3	dsl	380	Beth Breeze	370	5,000/3½"
Stouder Drlg Co	2	LPG	200	Natl T-12	160	4,000
LOUISIANA						
Acadia Parish						
Bullard Drlg Co Inc	1	stm	1000+	Natl 34-10 FE	1000+	16,000
Carter-Jones Drlg Co	10	gas-btne	—	—	500	7,000
Crawford Drlg Co	1	dsl	695	Brwstr N-7	500	9,000
Drlg & Expl Co of Delaware Inc	36	stm	1400	Natl 34-8	—	15,000
Kilroy Drlg Co	1	gas	600	"Oilwell" 96	1400	15,000
Lamar Drlg Corp	1	gas	420	Unit U-15	—	7,500
Loffland Bros Co	82	stm	—	—	—	15,000
Owen Drlg Co	4	stm	1000+	Emsco UBLS-54	—	14,000
	9	stm	740	Ideco Big Gnt	540	16,000
Sunnyland Contr Co Inc	3	stm	—	Emsco ECB	724	16,000
	8	gas-gaso	—	Crdwll D	312	8,000
Allen Parish						
Circle Drlg Co Inc	2	gas-btne	800	Brwstr N-75	900	11,000
Crown Rigs Inc	6	gas	900	Beth MC-450	600	10,000
Glasscock-Wilson Inc	10	gas	1050	Natl 55	800	10,500
Owen Drlg Co	8	dsl	1040	Natl 50	1040	9,500
Penrod Drlg Co	27	dsl	—	—	1095	11,000
Ascension Parish						
Dorris Ballew Inc	1	dsl	760	Wisn Titan	1300	12,500
Falcon Seaboard Drlg Co	34	stm	1200	Natl 3410	—	25,000
Assumption Parish						
Gilger Drlg Co	6	stm	1200	Natl	1200	15,000
Glasscock-Wilson Inc	8	gas	1600	Natl 110	1200	15,000
Gracey-Hellums Corp	Bge 2	stm	1200	Natl 23-9FE	1200	15,000
Grey Wolf Drlg Co	1	gas-btne	945	Emsco GB-800	—	12,500
Howell Holloway & Howell	7	stm	—	Emsco	600	15,500
W P Taylor Drlg Co	1	gas	—	Emsco	1000	13,000
Carnes W Weaver Drlg Co	Bge 1	dsl	2000	"Oilwell" 96	1700	16,000
Beauregard Parish						
Pernie Bailey	1	gas	650	TIW CT-5	—	9,000
Circle Drlg Co Inc	4	gas-btne	800	Brwstr N-75	960	11,000
Milton Crow Inc	4	gas	600	Brwstr N-75	—	10,000
Gulf Coast Drlg & Expl Inc	1	dsl	900	Natl 80-B	900	12,500
Penrod Drlg Co	22	dsl	—	—	600	9,000
	23	dsl	—	—	730	9,000
Bienville Parish						
Greyhound Drlg Co Inc	2	dsl	600	Brwstr N-45M	600	7,000
Nowery Drlg Co Inc	1	dsl	1000	Ideco 1050	1000	12,000
Penrod Drlg Co	38	gas-btne	—	—	1170	10,000
Bossier Parish						
B-M Drlg Co Inc	2	gas	685	Emsco GB-350	500	8,000
Burnham & Robinson Drlg Co	1	dsl	350	Brwstr N-5	350	7,000
Cook Drlg Co	21	gas-btne	475	Wisn Mogul	290	6,000
L & N Drlg Co	1	btne	226	Brwstr N-3	165	3,500
Penrod Drlg Co	11	gas	—	—	1425	12,000
Caddo Parish						
W C Allen Drlg Co	1	gas-btne	145	Wisn Super	78	3,000/3½"
	2	gas-btne	145	Wisn Super	78	3,000/3½"
Barnwell Drlg Co Inc	4	gas	500	Wisn Giant	185	5,000
Dudley C Beene Inc	2	dsl	285	Brwstr N-3	185	4,000
Crow Drlg & Prod Co	17	dsl	650	Brwstr CR-48T	650	7,500
Milton Crow Inc	3	gas	600	Brwstr N-7	—	7,500
Gary Drlg Co	1	btne	90	—	90	2,000
F E Hargraves & Sons Drlg Co	2	btne	185	Brwstr W-50	185	2,800/3½"
	3	btne	185	Brwstr W-50	185	2,800/3½"
	4	dsl	275	Brwstr N-A	300	6,000/3½"
L & N Drlg Co	2	btne	226	Wisn Super	110	2,500
McGoldrick & Watson Drlg Co	1	btne	145	Brwstr N-3	140	3,500
C M Roberson Drlg Co	1	gas-btne	400	Brwstr N-45	400	7,300
Tex-Mex Drlg Co	11	stm	—	—	1000+	12,000
Calcasieu Parish						
Comet Drlg Co	2	gas-btne	825	Natl 75	750	10,000
Delta Drlg Co	21	gas-btne	800	Natl 75	650	9,500
Owen Drlg Co	1	stm	540	Ideco Big Gnt	—	15,000
	3	gas	900	Ideco M-1000	—	12,500
Penrod Drlg Co	26	gas	—	—	730	9,000
Prince Marine Drlg & Expl Co	4	gas	1600	Emsco J-1100	1400+	14,000
Sunnyland Contr Co Inc	11	dsl	—	Ideco H-750	520	11,000
Cameron Parish						
Brewster-Bartle Drlg Co Inc	14	dsl	—	Natl 125	—	16,000
Delta Drlg Co	38	stm	530	Natl 239-S	1135	12,000
Harry L Edwards Drlg Co	6	stm	1000+	Natl 23-9S	1000+	15,000
Howell Holloway & Howell	4	dsl	—	Unit U-15	—	11,000
Win Hawkins Drlg Co	1	stm	—	Alco BIW 14	—	15,000
	3	stm	—	Emsco UBLS-54	—	14,000
Loffland Bros Co	41	stm	—	—	—	15,000
	59	stm	—	—	—	15,000
	81	dsl-elec	1150	—	1200	17,000
Mac Drlg Co	10	gas-btne	1000	Wisn Titan	1300	15,000
	12	stm	500	Natl 23-9-FED	1000+	15,000
	41	dsl	—	—	1000	12,000
	45	dsl	—	—	1500	20,000
Prince Marine Drlg & Expl Co	1	dsl	1500	"Oilwell" 96	1500	15,000
Carnes W Weaver Drlg Co	3	gas-btne	700	"Oilwell"	—	10,500
C B Webster Drlg Co	3	gas	900	Emsco J-1250	1300	15,000
Wheless Drlg Co	Bge 12	gas-btne	1200	Natl 80	800	12,000
Catahoula Parish						
Cook Drlg Co	20	gas-btne	900	Wisn Titan	975	12,500
Crow Drlg & Prod Co	19	dsl	325	Brwstr C-5	325	7,000/3½"
Justiss-Mears Oil Co Inc	6	dsl	250	Emsco G-250	325	7,000/4"
Petersen Petroleum Corp	5	gas	320	Crdwll S	350	6,000
Claiborne Parish						
Cook Drlg Co	18	gas-btne	670	Wisn Atlas	650	10,000
H & S Drlg Co	1	gas-btne	1000	Wisn Titan	1000	12,000
Kern Drlg Co Inc	1	dsl	260	Emsco GA-250	260	5,000
Montgomery Drlg Co	3	gas-btne	225	Crdwll S	200	5,000
Penrod Drlg Co	15	stm	—	—	—	15,000
Wheless Drlg Co	1	gas-btne	600	Brwstr N-45	600	7,500
	2	gas-btne	600	Wisn Atlas	700	8,500
	5	stm	900	Emsco UBLS-54	1000+	11,000
	13	gas-btne	700	Emsco J-750	750	10,500
Woolf & Magee Inc	5	gas-btne	800	Beth MC-450	800	11,000
Concordia Parish						
Justiss-Mears Oil Co Inc	10	dsl	250	Emsco G-250	325	10,000/2⅛"
Marlin Expl Inc	1	gas	500	Crdwll O	735	10,000
Woolf & Magee Inc	11	gas-btne	275	Beth S-45	275	10,000/2⅛"
De Soto Parish						
Dudley C Beene Inc	1	gas	145	Brwstr N-2	145	2,500
Kern Drlg Co Inc	3	dsl	260	Emsco GB-250	260	6,000
Nowery Drlg Co Inc	3	dsl	300	Natl T-32	3000	6,500
East Baton Rouge Parish						
L & H Drlg Co	1	gas	975	Natl 50-A	880	8,000
East Feliciana Parish						
Justiss-Mears Oil Co Inc	8	gas	300	Emsco G-250	325	7,000/4"
Evangeline Parish						
Glasscock-Wilson Inc	11	gas	1050	Natl 55	800	10,500
Penrod Drlg Co	4	gas-btne	—	—	1425	15,000
Franklin Parish						
Drlg & Expl Co of Del Inc	35	gas-gaso	1200	Emsco GB-800	900	12,000
Iberia Parish						
Clegg & Hunt	8	dsl	—	—	1275	18,000
Harry L Edwards Drlg Co	4	stm	1000+	Alco BIW 12	1000+	15,000
Loffland Bros Co	47	stm	—	—	—	15,000
Rowan Drlg Co Inc	Bge 26	dsl-elec	1455	Natl 100	1545	14,000
Wheless Drlg Co	Bge 6	gas-btne	1000	Wisn Titan	1000	12,000
Iberville Parish						
Frank Frawley Drlg Co	1	stm	—	Ideco Big Gnt	1200	13,000
Glasscock-Wilson Inc	12	gas	1300	Natl 110	1200	15,000
Hawkins-Wilkins Prod Co	1	stm	—	Natl 3410FE	—	15,000
L & H Drlg Co	2	gas	975	Natl 50-A	880	8,000
M M Lindsey Drlg Co	1	gas	380	Hou 876	—	7,500
Win Hawkins Drlg Co	2	gas-btne	300	Unit U-15	485	9,000
	4	stm	—	Natl 34-10FE	—	15,000
Jefferson Parish						
Brewster-Bartle Drlg Co Inc	10	dsl	—	"Oilwell" 76	—	11,000
Loffland Bros Co	45	stm	—	—	—	15,000
	63	stm	—	—	—	18,000
	65	dsl	1420	—	1510	18,000
Rowan Drlg Co Inc	Bge 1	dsl-elec	1600	Emsco ECA	2475	18,000
Jefferson Davis Parish						
Clegg & Hunt	1	stm	—	Emsco 10	—	15,000
	7	dsl	—	Natl 75	880	11,000

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Harry L Edwards Drlg Co	5	stm	1000+	Natl 23-10½ FE	1000+	16,000
	7	stm	1000+	Alco BIW 12	1000+	15,000
Gilger Drlg Co	3	stm	1000	Emsco	1000+	13,000
Glasscock-Wilson Inc	9	gas	1200	Natl 80-B	800	12,500
Grey Wolf Drlg Co	2	dsl-elec	1280	Alco BIW 12	1250	15,000
M M Lindsey Drlg Co	2	gas	290	Natl T-32	—	6,000
C B Webster Drlg Co	7	stm	1600	Emsco ECA-10½	1200+	15,000
Wheless Drlg Co	4	stm	1000+	Emsco UBLS-54	1000+	12,000
Lafayette Parish						
Delta Drlg Co	14	stm	900	Ideco Big Gnt	1690	15,000
	32	stm	1200	Ideco Big Gnt	1690	15,000
Falcon Seaboard Drlg Co	11	stm	1000+	Alco BIW 12	—	17,000
Owen Drlg Co	6	gas	555	Unit U-15	—	8,000
	7	stm	1000+	Emsco	—	16,000
R P Phillips Well Serv	7	gas	400	Wisn Giant	450	7,000
Lafourche Parish						
B B M Drlg Co	7	stm	—	Emsco EC-54	—	18,000
Brewster-Bartle Drlg Co Inc	3	dsl	—	"Oilwell" 96	1500	16,000
	5	dsl	—	"Oilwell" 96	1500	16,000
	6	dsl	—	"Oilwell" 96	1500	—
Circle Drlg Co Inc	3	gas-btne	1200	Natl 125	1400	15,000
Clegg & Hunt	4	stm	—	Ideco Big Gnt	—	15,000
Delta Drlg Co	5	gas-btne	900	Natl 100	800	12,000
Dixie Drlg Co Inc	3	gas	1350	Beth	1800	17,500
	4	dsl	1350	Beth	1500	17,500
Doc Drlg Corp	Bge DAN	dsl	1500	Beth 1013	1500	18,000
Blackie Drlg Co Inc						
Neva-Andre Drlg Corp						
	Bge DOC	dsl	1500	Beth Tornado	1500	15,000
	Bge NEVA	dsl	1500	Beth 1013	1500	18,000
C G Glasscock Drlg Co	2	dsl	1200	Natl 80-B	—	12,000
Howell Holloway & Howell	3	dsl	—	Emsco	696	15,000
	8	stm	—	Alco BIW DNT12	500	17,250
Loffland Bros Co	84	stm	—	—	—	18,000
	145	dsl	1225	—	1560	14,000
Mac Drlg Co	3	stm	600	Natl 23-9-S	1000+	15,000
Norton Drlg Co	Bge 2	stm	1200+	Natl 34-10	1500	17,000
	Bge 6	dsl	1400	Emsco J-1250	1200	17,000
Penrod Drlg Co	28	dsl	—	—	820	9,000
R P Phillips Well Serv	Bge 3	dsl	175	Wisn Giant	275	Workover
Rowan Drlg Co Inc	Bge 3	dsl-elec	2150	Emsco EDA	3455	20,000
	Bge 13	dsl-elec	1700	Emsco FCA	2700	18,000
	Bge 20	dsl	1120	Natl 75	1300	12,000
Shoreline Drlg Co Inc	Bge 4	dsl	1860	Unit U-1220	1860	20,000
Wheless Drlg Co	Bge 9	dsl	1300	Natl 130	1300	16,000
	Bge 11	gas-btne	1200	Emsco J-1250	1250	13,500
LaSalle Parish						
Woolf & Magee Inc	12	gas-btne	275	Beth S-45	275	8,000/2⅞"
Lincoln Parish						
Arrow Drlg Co	16	gas-elec	840	Emsco	—	10,000
Delta Drlg Co	8	stm	750	Ideco Supr-Duty	1200	12,000
Johnson Drlg & Serv Co	1	dsl	200	Beth-Broaze	200	4,500
Plaquemines Parish						
Brewster-Bartle Drlg Co Inc	1	dsl	—	"Oilwell" 96	1500	16,000
	12	dsl	—	"Oilwell" 96	1500	16,000
Clinch Drlg Co	1	dsl	—	Emsco GA-350	426	8,500
Cron & Gracey Corp	2	stm	—	Natl 23-9-FEC	—	15,000
	3	dsl	—	TIW CT-5	520	8,000
Delta Drlg Co	20	gas-btne	1520	Emsco J-1250	1250	15,000
Buster Gardner Drlg Co Inc	1	dsl	—	Beth M-58	—	9,500
Gracey-Hellums Corp	Bge 1	stm	1000	Natl 34-10FE	1200	15,000
Wm Hawkins Drlg Co	5	dsl	200	Ideco PR1050	900	15,000
Loffland Bros Co	48	dsl-elec	1150	—	1026	16,000
	68	dsl	1450	—	1500	18,000
	69	dsl	1120	—	1050	18,000
	73	dsl-elec	1030	—	1200	16,000
	128	dsl	1150	—	1200	18,000
	143	dsl	1220	—	1200	15,000
Penrod Drlg Co	40	dsl	—	—	1095	12,000
R P Phillips Well Serv	Bge 1	dsl	450	Crdwll D	520	9,000
Prince Marine Drlg & Exp Co	2	dsl	1850	"Oilwell" 96	1500	16,000
Rowan Drlg Co Inc	Bge 6	dsl-elec	1200	Emsco ED	2800	18,000
	Bge 14	dsl-elec	1600	Emsco ECA	2325	18,000
	Bge 18	stm	1800	Emsco ED	750	18,000
	Bge 21	dsl-elec	1000	Emsco ECA	1920	12,000
Salt Dome Prod Co	Bge 3	dsl	750	Natl 110	—	12,500
Southeastern Drlg Corp	20-Bge 6	dsl	1200	"Oilwell" 96	1100	16,000
	21-Bge 7	dsl	1200	"Oilwell" 96	1600	18,000
Red River Parish						
Scooter's Drlg Serv	4	dsl	300	Wisn Giant	300	4,500
St Bernard Parish						
La Delta Offshore Corp	"L.A. Jett"	dsl	—	Unit U-20	800	12,000
St. Charles Parish						
Loffland Bros Co	39	stm	—	—	—	15,000

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
R P Phillips Well Serv	Bge 2	gas	675	Beth 650	536	10,000
The Power Rig Drlg Co	8	gas-btne	1500	Ideco 7-11	—	15,000
Reading & Bates Inc	1	gas-btne	970	Natl 100	1200	12,500
St. James Parish						
Crawford Drlg Co	2	stm	—	Emsco ECA	500	15,000
Gulf Coast Drlg & Explo Inc	4	dsl	800	Natl T-32	800	6,500
C B Webster Drlg Co	8	stm	1600	Natl FE-34-10	1200+	15,000
St. Landry Parish						
Pernie Bailey	2	gas	800	Unit U-40	—	11,000
Crow Drlg & Prod Co	5	dsl	825	Brwstr N-7	825	9,000
Glasscock-Wilson Inc	7	gas	1200	Natl 80-B	800	12,500
St. Martin Parish						
Continental Drlg Co	7	dsl	1200	Emsco GB-800	1200	14,000
Falcon Seaboard Drlg Co	3	stm	1000+	Alco BIW 12	—	17,000
Gilger Drlg Co	4	stm	1000	Emsco	1000+	14,000
	5	stm	1000	Emsco	1000+	14,000
Grey Wolf Drlg Co	3	stm	1050	Alco BIW 12	—	13,500
Howell Holloway & Howell	5	dsl	—	Unit U-15	—	11,000
Loffland Bros Co	95	stm	—	—	—	18,000
R P Phillips Well Serv	4	gas	170	Crdwll S	225	5,000
The Power Rig Drlg Co	3	gas-btne	1000	Ideco 800	—	12,000
	4	gas-btne	700	Unit U-15	—	10,000
St. Mary Parish						
Bilbo-Redding Drlg Co Inc	10	stm	900	Emsco UBLS-54	1000+	12,500
Brewster-Bartle Drlg Co Inc	2	dsl	—	"Oilwell" 96	1500	16,000
	4	gas	—	"Oilwell" 76	—	11,000
Bullard Drlg Co Inc	2	stm	1000+	Emsco ECB	1000+	16,000
	3	stm	1000+	Ideco Big Gnt	1000+	16,000
Circle Drlg Co Inc	Bge 6	dsl-elec	2300	Ideco E2500	2750	20,000
Buster Gardner Drlg Co Inc	2	dsl	—	Beth Tornado	—	15,000
C G Glasscock Drlg Co	4	dsl	1700	Natl 125	—	16,000
	6	dsl	1660	Natl 110	—	16,000
Grey Wolf Drlg Co	4	gas-btne	585	Emsco GB-500	—	9,500
Kelly Drlg Co Inc	1	stm	600	Ideco Jr Gnt	1200	15,000
Loffland Bros Co	93	stm	—	—	—	18,000
Norton Drlg Co	Bge 3	stm	1200+	Natl 34-62	1500	17,000
	Bge 4	dsl	1400	Emsco J-1250	1500	17,000
	Bge 5	dsl	1200	"Oilwell" 96	1200	17,000
The Power Rig Drlg Co	Bge 7	dsl	1200	Emsco GB-800	—	15,000
Shoreline Drlg Co Inc	Bge 5	dsl	1240	Unit U-40	1200	12,500
Southeastern Drlg Corp	9-Bge 2	dsl	1200	"Oilwell" 96	1600	18,000
	14-Bge 1	dsl	1200	"Oilwell" 96	1600	18,000
Wheless Drlg Co	Bge 14	dsl	1300	Emsco J-1400	1400	16,000
Tensas Parish						
J B Fletcher Drlg Co	1	gas-btne	—	Unit U-15	600	7,500
Jett Drlg Co Inc	4	dsl	—	—	1100	13,000
	5	dsl	—	—	600	7,500
Justiss-Mears Oil Co Inc	1	gas	350	Emsco GA-500	560	10,500/4"
Pyburn Drlg Co	1	dsl	500	Ideco M-750	750	9,000
Thrasher Drlg Co Inc	1	gas-btne	350	Unit U-15	600	8,500
Terrebonne Parish						
An-Son Gulf Drlg Co	4	dsl	650	Natl 75	975	11,000
Brewster-Bartle Drlg Co Inc	7	dsl	—	"Oilwell" 96	1500	16,000
	8	dsl	—	"Oilwell" 96	1500	16,000
	11	dsl	—	"Oilwell" 96	1500	16,000
Clegg & Hunt	11	dsl-elec	2600	Ideco 2500	1900	23,000
Continental Drlg Co	6	dsl	650	Emsco GB-500	650	11,000
Continental Shelf Drlg Corp	Belle Clarie	dsl	1700	Beth 1013	1950	18,000
Cron & Gracey Corp	4	dsl	1450	"Oilwell" 96	1290	15,000
Delta Drlg Co	11	stm	1000	Emsco UBLS-54	1680	15,000
	19	stm	1200	Natl 34-10-FE	1690	15,000
Dixie Drlg Co Inc	2	dsl	1350	Beth	2000	17,500
Falcon Seaboard Drlg Co	2	stm	1200+	Ideco Gnt	—	25,000
	12	stm	1200	Alco BIW 12	—	25,000
Buster Gardner Drlg Co Inc	3	dsl	—	Beth 1013	—	17,500
C G Glasscock Drlg Co	5	dsl	1060	Natl 75	—	12,000
Gracey-Hellums Corp	Bge 3	dsl	1775	Unit U-12-20	1800	20,000
Kelly Drlg Co Inc	2	pwr	600	"Oilwell" 96	1500	18,000
	3	pwr	825	"Oilwell" 96	1500	18,000
Loffland Bros Co	61	stm	—	—	—	18,000
	83	stm	—	—	—	15,000
Penrod Drlg Co	33	gas-btne	—	—	1230	12,000
	44	dsl-elec	—	—	1400	18,000
	46	dsl-elec	1250	Emsco ECB	1250	20,000
	47	dsl-elec	1280	Emsco EDA	1250	20,000
The Power Rig Drlg Co	Bge 6	gas-btne	800	Emsco GB-500	—	11,000
Shoreline Drlg Co Inc	Bge 6	dsl-elec	1700	Natl 23-9	1700	16,000
C B Webster Drlg Co	4	stm	1200	Natl FE-34-10	1200+	15,000
	5	stm	1350	Natl FE-23-10½	1200+	15,000
Wheless Drlg Co	7	stm	1000+	Emsco UBLS	1000+	15,000
	Bge 8	dsl	1300	Natl 130	1455	16,000
	15	dsl	1975	Natl 130	1455	16,000

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Union Parish						
Big Chief Drlg Co	31	gas	1545	Emsco 800	1515	13,500
Cook Drlg Co	10	gas-btne	900	Wlsn Titan	975	12,500
Vermilion Parish						
Circle Drlg Co Inc	5	gas-btne	1200	Brwstr N-12	1440	15,000
Clegg & Hunt	6	stm	—	Natl 9-DMB	—	14,000
Columbia Drlg Co	Bge 1	dsl	600	"Oilwell" 76	750	12,000
Comet Drlg Co	1	stm	1200	Ideco Big Gnt	—	16,000
Crown Rigs Inc	Bge 1	dsl	1200	Beth 1013	1200	15,000
Delta Drlg Co	31	gas-btne	1020	Emsco J-1000	1260	13,000
Dillard-Waltermire Inc	6	stm	1200	Natl 34-10FE	1500	16,000
	8	stm	1200	Natl 34-10FE	1500	16,000
Dixie Drlg Co Inc	1	dsl	1350	Beth	1500	17,500
Drlg & Expl Co of Delaware Inc	32	stm	1400	Emsco ECA	—	15,000
Harry L Edwards Drlg Co	Bge 10	dsl	—	Ideco PR-1050	—	16,000
Falcon Seaboard Drlg Co	29	stm	1200+	Natl 3410	—	25,000
C J Foster Drlg Co Inc	1	stm	—	Natl	1000+	18,000
Loffland Bros Co	60	stm	—	—	—	15,000
	76	stm	—	—	—	18,000
Mac Drlg Co	11	stm	800+	Natl 23-9 FE	1000+	16,000
Mosier & King Well Serv Inc	1	gas	450	Beth MC-250	340	14,000/2⅞"
C B Webster Drlg Co	6	stm	1100	Emsco ECA-10½	1200+	15,000
Webster Parish						
Cook Drlg Co	19	gas-btne	900	Wlsn Titan	975	12,500
Greyhound Drlg Co Inc	3	dsl	1000	Brwstr N-7	825	8,000
Penrod Drlg Co	35	stm	—	—	—	15,000
	36	stm	—	—	—	14,000
Scooter's Drlg Serv	2	dsl	300	Brwstr N-4	300	4,500
Wheless Drlg Co	Bge 10	gas-btne	900	Brwstr N-7	700	9,500
Williams Drlg Co Inc	1	dsl	278	Wlsn Mogul	172	4,000
Woolf & Magee Inc	1	stm	1000+	Natl 34-10 FE	1200+	15,000
	8	gas-btne	1300	Beth Tornado	1300	15,000
MARYLAND						
Garrett County						
Delta Drlg Co	33	gas-btne	624	Natl 50-A	450	7,000
MICHIGAN						
Branch County						
Calvert Drlg Inc	12	dsl	260	Ideco H-30	260	4,500
Crawford County						
Fen-Par Expl Co Inc	1	dsl	100	Failing 1500	100	1,500
Gladwin County						
Gordon Drlg Co	10	gas-LPG	600	"Oilwell" 66	500	9,500
Hillsdale County						
Gordon Drlg Co	1	gas-LPG	250	"Oilwell" 64	225	4,000
Manistee County						
Gordon Drlg Co	7	gas-LPG	500	"Oilwell" 64-B	400	5,000
Mason County						
Union Rotary Corp	5	dsl	475	Natl 50	575	7,500
Midland County						
Gordon Drlg Co	11	dsl	600	Wlsn Roadair	500	10,000
Oceana County						
Bernhardt Drlg Co	1	dsl	300	Failing 2500	300	2,700/3½"
Osceola County						
Gordon Drlg Co	3	gas-LPG	500	"Oilwell" 64-B	400	5,000
	8	gas-LPG	600	Natl 50-A	500	9,000
Union Rotary Corp	7	gas-LPG	220	"Oilwell" 64	220	6,000
Ottawa County						
Fen-Par Expl Co Inc	2	dsl	100	Failing 1500	100	1,500
Roscommon County						
Union Rotary Corp	8	dsl	475	Natl 50	575	7,500
Saginaw County						
Gordon Drlg Co	12	dsl	600	Wlsn Gnt	550	10,000
St. Clair County						
Union Rotary Corp	3	gas-LPG	200	Natl 40	180	4,000
Wayne County						
Eakle & Holder Drlg Co	2	dsl	200	Emsco G-300	—	5,500
MISSISSIPPI						
Adams County						
Dorris Ballew Inc	2	dsl	760	Wlsn Titan	1300	12,500
	6	dsl	380	Unit U-15	600	7,500
Jett Drlg Co Inc	3	dsl	—	—	600	7,500
	7	dsl	—	—	500	7,500
Marlin Exploration Inc	4	dsl	500	Unit U-15	600	8,500
Sunnyland Contr Co Inc	7	dsl	—	Ideco H-40	450	8,000
Chickasaw County						
Dorris Ballew Inc	8	dsl	1380	Natl 125	1725	16,000
Clarke County						
Dorris Ballew Inc	4	dsl	760	Wlsn Titan	1900	15,000
Clay County						
Drlg & Expl Co of Del Inc	37	gas-gaso	1200	Emsco GB-800	900	12,000
Covington County						
Zach Brooks Drlg Co	8	gas	2600	Brwstr N-12	2600	18,000
Forrest County						
Crow Drlg & Prod Co	16	dsl	1100	Brwstr N-10	1100	12,000
Sunnyland Contr Co Inc	9	dsl	—	Crdwll D	450	8,000
Marshall R Young Drlg Co	12	—	740	Natl 50-A	558	8,000
Franklin County						
Index Drlg Co	2	dsl	1200	Unit U-40	900	13,000
Wilson Drlg Co Inc	1	dsl	212	Ideco H-35-D	424	8,500/3½"
Greene County						
Jett Drlg Co Inc	2	dsl	—	—	700	9,000
Hancock County						
Marshall R Young Drlg Co	7	stm	2888	Natl 34	1480	16,000
Hinds County						
Jett Drlg Co Inc	6	gas-gaso	—	—	800	9,500
Larco Drlg Co	6	dsl	1600	"Oilwell" 96	1600	18,000
Issaquena County						
Zach Brooks Drlg Co	4	gas	1350	Brwstr N-75	1350	12,000
Jasper County						
Drlg & Expl Co of Del Inc	23	gas-gaso	1000	Natl 100	900	12,000
Jefferson County						
Justiss-Mears Oil Co Inc	9	gas	650	Emsco GA-300	560	11,000/4"
Marshall R Young Drlg Co	3	—	900	Natl 75	830	10,000
Jones County						
Zach Brooks Drlg Co	1	gas-btne	1350	Brwstr N-95	1350	14,000
Drlg & Expl Co of Del Inc	39	gas-gaso	1200	Emsco J-1100	1050	15,000
Lawrence County						
Marshall R Young Drlg Co	11	—	945	Wlsn Titan	1122	14,000
Lincoln County						
Index Drlg Co	3	LPG	300	Wlsn Mogul	300	8,500/3½"
Marshall R Young Drlg Co	6	stm	2888	Natl 34	1480	16,000
	8	—	945	Wlsn Titan	1122	14,000
Pearl River County						
Crawford Drlg Co	3	stm	—	"Oilwell" 9	500	10,500
Larco Drlg Co	5	gas	1000	"Oilwell" 76	1000	10,000
Sunnyland Contr Co Inc	12	dsl	1120	Ideco H-525 SC	1000	10,000
Perry County						
Index Drlg Co	1	LPG	250	Wlsn Mogul	250	6,500/3½"
Larco Drlg Co	2	dsl	1200	"Oilwell" 96	1200	14,000
Rankin County						
Arrow Drlg Co	5	gas	1250	Emsco	—	14,000
Drlg & Expl Co of Del Inc	41	gas-gaso	1500	Emsco J-1100	1050	15,000
A W Williams Drlg Co Inc	1	dsl	186	Joy 300	200	5,500/2⅞"
Sharkey County						
Zach Brooks Drlg Co	7	dsl	1350	Brwstr N-75	1350	12,500
Smith County						
Dixilyn Drlg Corp	1	gas	900	Natl 75	650	12,000/3½"
	5	gas	950	Natl 100	950	14,000
Marshall R Young Drlg Co	5	—	945	Wlsn Titan	1122	14,000
Walthall County						
Gulf Coast Drlg & Expl Inc	2	dsl	1200	Natl 110	1200	14,000
	3	dsl	900	Natl 80-B	900	12,500
Wayne County						
Cook Drlg Co	16	gas-btne	1050	Wlsn Titan	975	12,500
Larco Drlg Co	4	dsl	1200	"Oilwell" 96	1200	14,000
Marshall R Young Drlg Co	1	—	740	Natl 75	648	10,000
Wilkinson County						
Woolf & Magee Inc	10	gas-btne	275	Beth Breeze	275	8,000/2⅞"
MONTANA						
Custer County						
Anschutz Drlg Co Inc	10	dsl	800	Brwstr N-55	600	7,500
Daniels County						
Brinkerhoff Drlg Co	17	dsl	900	Emsco GB-800	1000	12,500
J D Sprecher	4	dsl	1000	Natl 80-B	1000	12,000
Dawson County						
J D Sprecher	6	dsl	750	Emsco A-550	750	9,000
Fallon County						
Zach Brooks Drlg Co	6	dsl	1300	Brwstr N-75	1300	12,500
Pioneer Drlg Co Inc	6	dsl	850	Emsco GB-800	1000	12,000
Garfield County						
Taylor Expl Co Inc	4	gaso	—	Mayhew	75	1,000
	6	gaso	—	Mayhew	—	1,000
Glacier County						
Brinkerhoff Drlg Co	8	dsl	1200	Natl-110	1200	15,000
Kullberg & Otthouse Inc	1	dsl	300	Unit U-15	—	7,500
Liberty County						
Grannell Drlg Co	1	dsl	450	Unit U-15	450	6,000
Musselshell County						
Anschutz Drlg Co	12	gas	830	Brwstr N-45	530	6,500
Hose-Austin Drlg Corp	2	dsl	250	Emsco GB-160T	250	5,000/3½"
	3	gas	450	Unit U-15	550	7,000
Roosevelt County						
Zach Brooks Drlg Co	3	dsl	900	Brwstr N-7	900	8,500
	5	dsl	800	Brwstr N-7	800	8,500
Rosebud County						
Hose-Austin Drlg Corp	1	dsl	350	Emsco GB-250T	450	6,000



This is the rig for 8,000 ft. drilling!

. . . say Drilling Contractors EVERYWHERE

This "Oilwell" No. 66 Rig is doing a great job for another West Texas Contractor

FROM Canada to South America . . . from California to Pennsylvania . . . Drilling Contractors, one by one, are discovering that it pays to back up their bids on 8,000 ft. work with an "Oilwell" No. 66 Rig and companion profit-making equipment.

In fields where proven production is under development, crews have drilled an extra well with No. 66 Rigs, in time saved drilling four or five wells where average equipment is in use.

MOVING time is saved . . . because this lightweight, fully-unitized draw works with two or three engines and drive, is mounted on a single skid base. This greatly reduces tearing down, moving and rigging-up operations.

OPERATING time is saved . . . because fast-acting air controls make the horsepower respond immediately to the driller's needs, whether the rig be furnished with straight mechanical or torque converter drive.

MAINTENANCE time is saved . . . because major rotating parts are oil lubricated by a forced-feed circulating system and a minimum number of grease fittings are employed. Guards are fabricated to provide quick access to the inside of the draw works for inspections and adjustments.

BEFORE YOU BUY . . . another rig in this class, let us show you the nearest No. 66 "on location." You'll see for yourself why an ever-growing list of Drilling Contractors are saying: "This is the rig for 8,000 ft. drilling."

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"OILWELL"

TRADE MARK

UNITED STATES STEEL

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Sheridan County						
Helmerich & Payne Inc	33	gas	850	"Oilwell" 76	1100	11,000
Rowan Drlg Co Inc	5	gas-btne	840	Natl-75	1120	11,000
Treasure County						
R L Manning Co	8	dsl	550	Emsco G-500	550	7,500
Wibaux County						
Helmerich & Payne Inc	15	dsl	700	"Oilwell" 76	1000	11,000
Hewit-Gulick Drlg Co	2	dsl	970	Natl-80	900	12,000
Yellowstone County						
Tom Knight	1	gaso	250	Union Tool	—	5,000
Reliable Drlg Co	1	gas	350	Union Tool	350	5,000
NEBRASKA						
Banner County						
Brinkerhoff Drlg Co	10	dsl	275	Natl T-32	275	5,500
Exeter Drlg Co	1	dsl	325	Emsco GA-350	425	7,000
Garvey Drlg Co	17	dsl	300	Wisn Roadair	450	7,000/3½"
	19	dsl	300	Wisn Roadair	450	7,000/3½"
Herndon Drlg Co	2	gas	600	Natl 50-A	750	10,500
Don Johnston Drlg Co	1	dsl	270	Natl T-12	195	5,000
	3	gas-btne	650	Natl 50	650	7,500
Lewis Bros Inc	1	dsl	376	Crdwll J-450	476	7,500
Lohmann-Johnson Drlg Co Inc	1	dsl	300	Natl 50	480	5,500
McDaniel Drlg Co	1	dsl	350	Ideco H-40	350	6,000
Strain Drlg Co	1	dsl	325	Unit U-15	600	7,500
Zephyr Drlg Corp	12	dsl	258	Beth S-45-E	165	7,000/2⅞"
Cheyenne County						
Garvey Drlg Co	16	dsl	300	Wisn Roadair	450	7,000/3½"
Kimball County						
Ashby Drlg Co Ltd	1	dsl	300	Natl T-20	300	8,000/3½"
	2	dsl	300	Natl T-20	300	8,000/3½"
Brinkerhoff Drlg Co	11	dsl	275	Natl T-20	275	5,500
Miracle-Fifer Drlg Co	1	btne	300	Unit U-15	660	8,500
Don M Rounds Drlg Co Inc	1	dsl	350	Natl 50	350	6,000
	2	dsl	900	Crdwll 0	900	9,000
Richardson County						
Nemaha Oil Co	1	dsl	370	Frnks Sal 3000	370	4,500/3½"
Sioux County						
Brack Drlg Co Inc (Colo)	6	dsl	—	—	606	8,500
NEVADA						
Churchill County						
Barry Well Drlg Co	2	dsl	200	—	—	3,000/3½"
Eureka County						
Colorado Wyoming Drlg Co	1	dsl	300	Natl 50-A	600	9,000
NEW MEXICO						
Eddy County						
Delta Drlg Co	3	gas-btne	900	Natl 100	800	12,000
Denver Drlg Corp	1	gas	370	Crdwll EC	370	5,000
Donnell Drlg Co	14	btne	—	Ideco H-40	370	4,000
Great Western Drlg Co	12	gas-gaso	—	—	1755	16,000
	18	dsl	—	—	1200	15,000
Carl B King Drlg Co of Tex	3	gas-gaso	1000	Natl 100	1000	13,500
Midland Drlg Co	1	gas-btne	600	Unit U-15	600	8,000
Rowan Drlg Co Inc	9	gas-btne	900	Natl 75	1110	11,000
	12	gas-btne	1260	Natl 100	1680	14,000
Urice Drlg Co	6	gas-btne	280	Wisn Super	145	3,000
S P Yates Drlg Co	2	dsl	350	Unit U-15	—	6,500
Lea County						
Brantly Drlg Co Inc	3	gas	700	Brwstr N-75	750	11,000
Carper Drlg Co Inc	4	gas-btne	650	Beth S-55	560	6,000
	5	gas-btne	675	Unit U-15	675	8,000
Coroco Drlg Co	2	gas-gaso	650	"Oilwell" 96	900	15,000
Clark Dale Drlg Co Inc	1	gas	—	"Oilwell" 76	1000	12,500
	2	gas	—	Natl 50	600	8,500
Delta Drlg Co	6	gas-btne	800	Emsco J-750	750	9,500
	9	gas-btne	936	Natl 100	800	12,000
Denver Drlg Corp	2	gas	550	Natl 50	550	8,500
	3	gas	220	Unit U-34	290	5,000
Dillard-Waltermire Inc	9	gas	800	Natl 100	1200	13,500
Donnell Drlg Co	5	gas-btne	650	Unit U-15	650	8,000
	12	btne	400	Beth S45E	—	5,000
Durham Drlg Co Inc	4	gas	1250	Ideco 7-11	1450	15,000
Exploration Drlg Co	7	gas	1200	Natl 80-B	1350	13,000
Frank Frawley Drlg Co	4	gas	—	Unit U-40	850	10,000
Great Western Drlg Co	35	gas-gaso	—	—	630	7,500
Helmerich & Payne Inc	25	gas	1100	"Oilwell" 96	1100	14,000
	32	gas	1100	"Oilwell" 96	1100	14,000
	43	gas	700	"Oilwell" 76	700	11,000
Hissom Drlg Co	1	gas	600	Emsco 500	600	8,500
Johnn Drlg Co	6	gas	850	Brwstr N-95	1300	14,000
	8	gas	500	Brwstr N-75	700	10,000
Kerr-McGee Oil Ind Inc	3	gas	800	Natl 75	832	11,500
	7	gas	900	Natl 75	818	11,500
Carl B King Drlg of Tex	20	gas	2100	"Oilwell" 96-16	2100	20,000
La Mance Drlg Co	1	btne	350	Frnks 5000	—	5,000
	3	btne	550	"Oilwell" 64	—	6,500
Laughlin-Porter Drlg Co Inc	6	gas	1000	Wisn Titan	—	14,000
Llano Drlg Co	1	dsl	1175	"Oilwell" 96	1200	15,000
Loffland Bros Co	20	gas	1000	—	1600	20,000
	64	gas	970	—	960	14,000
Lowe Drlg Co	1	gas	500	Unit U-15	—	7,500
	2	gas	750	Natl 75	—	10,000
	4	gas	1000	Natl 125	—	12,500
	5	gas	750	Natl 75	—	10,000
	6	gas	500	Unit U-15	—	7,500
	7	gas	750	Wilson	—	10,000
	8	gas	1200	Natl 80	—	12,500
	10	gas	1000	Wilson	—	12,500
McAlester Fuel Co	—	btne-gas	—	Emsco J-1100	1050	14,000
	—	btne-gas	—	Natl 100	1050	14,000
Makin Drlg Co	1	gas-gaso	975	Wisn Titan	1300	13,000
	2	gas-gaso	650	Wisn Giant	600	8,000
	3	gas-gaso	975	Wisn Titan	1300	13,000
	4	gas-gaso	975	Wisn Titan	1300	13,000
	5	gas-gaso	700	Wisn Titan	700	10,000
	7	gas-gaso	975	Wisn Titan	1300	12,000
	8	gas-gaso	1050	Wisn Titan	1050	13,000
	9	gas-gaso	450	Wisn Giant	400	5,000
	10	gas-gaso	650	Wisn Giant	600	8,000
Moran Oil Prod & Drlg Corp	2	gas	—	Natl 75	750	10,000
	4	gas	—	Unit U-34	300	5,000
Nichols Drlg Co	6	gas-btne	1050	Wisn Titan	1050	15,000
R Olsen	1	gas	660	Wisn Giant	660	9,000/3½"
	2	gas	470	Wisn Giant	290	5,000
	3	gas	585	Hou Prtble	300	5,000
	4	gas	1101	Wisn Titan	1101	12,500
Parker Drlg Co	4	gas	—	Natl L-100	1400	14,000
	41	gas	—	Natl L-100	1400	14,000
	42	gas	—	Natl L-100	1400	14,000
	45	gas	—	Natl L-125	1400	15,000
	49	gas	—	Natl L-125	1400	15,000
	51	gas	—	Natl 50	700	9,000
	52	gas	—	"Oilwell" 76	1400	12,500
	54	gas	—	Natl L-125	1400	20,000
	55	gas-elec	—	Natl L-130	2000	20,000
Rowan Drlg Co Inc	7	gas-btne	1260	Natl 100	1680	14,000
Schafer Drlg Co	3	gas-gaso	400	Unit U-15	600	10,000
Schoenfeld-Hunter-Kitch Drlg Co	6	LPG-gas	—	Beth 650	1000	14,000
Sharp Drlg Co	34	gas	1350	Beth 1013	1350	16,000
A W Thompson Inc	2	gas	650	Beth 10-13	1650	16,000
	3	gas	650	Emsco 800	1050	13,500
	5	gas	650	Beth 810	1050	13,500
	7	gas	650	Beth 450	1050	11,000
	9	gas	650	Clark Pr-1000	1050	13,500
	11	gas	650	Beth 450	1050	13,500
Warton Drlg Co	3	gas	970	Natl 110	1600	14,000
S P Yates Drlg Co	1	dsl	350	Wisn 42 Torcair	—	5,000
Rio Arriba County						
Brannon & Murray Drlg Co	3	gas-LPG	250	Brwstr N-4	250	5,000
D-K Drlg Co	2	gas	675	Natl 80	675	7,500
Dillard-Waltermire Inc	10	gas	600	Wisn Giant	800	8,000
	11	gas	600	Wisn Giant	800	8,000
Empire States Drlg Corp	1	gas	225	Unit U-34 Trlr	225	5,000
	3	gas	225	Crdwll L	225	4,000
Fleeger Drlg Inc	1	dsl	325	Beth Twstr	600	8,500
	6	dsl	450	Unit U-15	600	8,500
	7	dsl	360	Beth 45-E	500	5,000
Great Western Drlg Co	32	dsl	—	—	750	7,500
Nichols Drlg Co	3	gas-btne	700	Natl 50-A	700	9,000
Paul F Rutledge	2	gas	650	Beth M-58	650	10,500
	4	gas	525	Beth C-50	525	7,000
	5	gas	650	Natl 80	650	7,000
Roosevelt County						
Great Western Drlg Co	25	gas-gaso	—	—	1125	15,000
Sandoval County						
Miracle-Fifer Drlg Co	2	btne	300	Unit U-15	660	8,500
George W Riley Inc	20	gas-gaso	200	Crdwll S	—	4,500
San Juan County						
Arapahoe Drlg Co	1	gas-btne	300	Natl T-32	320	6,000
	3	gas-btne	300	Wisn Mogul	275	5,000
Black Hills Drlg Co Inc	1	dsl	450	Emsco GA-350	—	7,500
Brinkerhoff Drlg Co	23	dsl	375	Natl T-20	275	5,500
	24	dsl	375	Natl T-20	275	5,500
Durham Drlg Co Inc	1	gas	500	Unit U-15	660	8,500
Empire States Drlg Corp	2	gas	530	Ideco H-35	530	6,500
	4	gas	225	Wisn Spr	225	3,000
Foree Drlg Co	1	gas-btne	325	Unit U-34	300	4,500
	3	gas-btne	325	Unit U-15	600	7,500

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Foree Drlg Co	5	btne	350	"Oilwell" 52-T	426	6,000
Gardner Bros Drlg Co Inc	9	gas-btne	450	Unit U-15	675	7,000
	17	gas-btne	550	Natl 50-A	700	8,500
	19	gas-btne	185	Crdwll R	200	3,300
Great Western Drlg Co	23	dsl	—	—	800	7,500
Herndon Drlg Co	4	gas	480	Emsco G-450	630	7,000
Loffland Bros Co	91	gas	600	—	640	8,000
H B Lynn Drlg Corp	1	gas-btne	700	Natl 50	—	7,500
	2	gas-btne	700	Natl 50	—	7,500
	3	gas-btne	700	Natl 50	—	7,500
Miracle-Fifer Drlg Co	3	btne	300	Unit U-34	420	6,000
George W Riley Inc	4	gas-gaso	750	Crdwll O	—	10,000
	21	gas-gaso	300	Crdwll Trlr	—	5,500
	41	btne	750	Unit U-15	660	10,000
San Miguel County						
Riceland Corp	1	gas	250	Ideco H-25	—	3,000
Union County						
Schafer Drlg Co	4	gas-gaso	200	Unit U-34	200	6,000
NEW YORK						
Schuyler County						
Gordon Drlg Co	S-7	dsl	300	Crdwll S	300	4,500
NORTH DAKOTA						
Billings County						
Helmerich & Payne Inc	29	gas	700	Natl 75CA	1100	11,000
J D Sprecher	2	dsl	900	Emsco J-750	900	9,500
Bottineau County						
Cardinal Drlg Co (Bismarck)	1	dsl	320	Emsco GB-250	320	5,500
	2	dsl	320	Natl T-20	320	5,000
	3	dsl	280	Frnks	280	3,000
Penrod Drlg Co	9	dsl	—	—	385	6,000
Burke County						
Calvert Drlg Co	24	gas-btne	600	Unit U-15	600	9,000
Loffland Bros Co	138	dsl	670	—	600	9,000
M-H-O Drlg Co	8	gas-btne	800	Unit U-15	800	8,000
Penrod Drlg Co	19	dsl	—	—	730	9,000
Signal Expl Inc	2	dsl	370	Unit U-36-A	420	7,500
	3	dsl	370	Unit U-36-A	420	7,500
Divide County						
Calvert Drlg Inc	23	dsl	350	Ideco H-526	600	8,500
McKenzie County						
Anschutz Drlg Co Inc	14	gas	900	Brwstr N-7	600	8,500
Brinkerhoff Drlg Co	5	dsl	650	Emsco J-750	800	10,000
	21	dsl	650	Emsco GC-500	800	10,000
Helmerich & Payne Inc	8	gas	600	Natl 55	800	9,000
Loffland Bros Co	16	gas	970	—	1260	14,000
	124	gas	870	—	960	11,000
Gabe McCall Drlg Co	3	gas	840	Natl 80	840	9,000
Penrod Drlg Co	31	dsl	—	—	1200	10,000
Rowan Drlg Co Inc	15	gas-btne	1140	Natl 75	1503	11,000
	23	gas-btne	1140	Natl 75	1503	11,000
Paul F Rutledge	1	gas	975	Beth M-450	975	12,000
Rolette County						
Calvert Drlg Inc	22	gas-btne	320	Ideco H-35	330	5,500
Stark County						
Paul F Rutledge	3	gas	650	Beth M-450	650	12,000
Williams County						
Exploration Drlg Co	6	gas	310	Beth S-50	200	5,500
	9	gas	310	Beth S-50	250	5,500
Penrod Drlg Co	21	dsl	—	—	385	6,000
Rowan Drlg Co Inc	27	gas-btne	1350	Natl 125	1530	15,000
OHIO						
Fayette County						
Union Rotary Corp	4	dsl	475	Natl 50	575	7,500
OKLAHOMA						
Alfalfa County						
Barrett Petroleum Co	2	gas-gaso	—	Natl 50	450	6,800
	5	gas-gaso	—	Brwstr N-7	750	8,500
Calvert Drlg Inc	21	dsl	350	Ideco H-35	260	6,500/4"
Lohmann-Johnson Drlg Co Inc	8	dsl	300	Natl 32	550	7,500
Summit Drlg Corp	3	gas	—	Emsco 450	450	7,000
Viersen & Cochran	12	gas	325	Natl T-25	225	5,500
	14	gas	325	Natl T-25	225	5,500
Webster Drlg Co	5	gas-btne	450	Natl 50	450	7,500
Beaver County						
Arrow Drlg Co	20	gas	460	Emsco 350	—	7,000
Falcon Seaboard Drlg Co	16	gas-btne	425	Unit U-15	425	8,500
Graham-Michaelis Drlg Co	2	dsl	500	Unit U-15	500	7,000
Helmerich & Payne Inc	7	gas	500	Emsco GB-500-82	700	9,000
Holm Drlg Co	6	dsl	750	Wisn Roadair	600	8,500
Midwestern Drillers Inc	3	dsl	370	Unit U-15	600	7,500
	4	gas	500	Emsco 500	650	8,000
Moran Bros Inc	16	gas	650	Unit U-15	700	7,500
R W Rine Drlg Co	4	dsl	520	Brwstr N-75	700	8,500
Service Drlg Co	3	LPG	650	Unit U-15	—	8,500
Sikes-Burckhalter	1	—	500	Wisn Giant	750	8,500
Unit Drlg Co	3	dsl	700	Natl 50-A	700	6,500
Wagner & Wyant Drlg Co Inc	2	dsl	300	Unit U-15	675	8,000
Webster Drlg Co	7	gas-btne	700	Unit U-15	700	8,500
Beckham County						
Beckman Inc	17(wo)	gas	150	MIW P-42	200	10,000/2⅛"
Helmerich & Payne Inc	47	gas-btne	2000	"Oilwell" 96	2000	20,000
Johnson & Flesher Drlg Co	250	gas	255	Emsco GA-250	350	6,000
Blaine County						
Perkins Bros Drlg Co	4	gas-btne	1200	Beth 650	1200	12,000
Schafer Drlg Co	1	gas-gaso	1200	Unit U-40	900	12,000
Bryan County						
Viersen & Cochran	4	gas	600	Natl 75	650	10,500
Caddo County						
Arrow Drlg Co	25	gas	840	Ideco 1000	—	10,000
Big Chief Drlg Co	2	gas	1875	Natl 125	1815	16,000
Graham Drlg Co	1	gas-btne	235	Wisn Mogul	285	5,000
Helmerich & Payne Inc	38	gas	850	Natl 80	1100	11,000
G H Ray Well Serv	1	prop-gas	200	Wilson	200	4,500
Carter County						
Berry Drlg Co	1	dsl	350	Wisn Giant	500	6,500
Fain-Porter Drlg Corp	3	gas	375	Emsco GA-250	400	6,000
Flournoy-Haston Drlg Co Inc	1	gas	275	Unit U-34	200	4,500
Graves Drlg Co	1	dsl	300	Frnks 4000-A	330	3,500
	2	gas	195	Frnks	100	2,000
Holliman Drlg Co	3	gas	255	Unit U-15	600	7,500
Nelson Drlg Co	1	gas	450	Unit U-15	450	6,500
	3	gas	225	Unit U-34	400	4,500
	4	gas	650	Unit U-15	650	9,000
Perkins Bros Drlg Co	3	gas-btne	400	Beth S-60	370	7,500
Sherin Drlg Co	2	gas-gaso	500	Unit U-15	600	8,000
Cimarron County						
Helmerich & Payne Inc	46	gas	530	Emsco GB-500-52	700	9,000
Cleveland County						
Beckman Inc	18(wo)	gas	150	MIW P-42	200	10,000/2⅛"
Big X Drlg Co Inc	1	gas-gaso	750	Beth MC-450	750	9,000
C H & C Drlg Co	1	gas	300	Unit U-15	680	9,000
N V Duncan Drlg Co	2	gas	600	"Oilwell" 64-B	600	9,000
	4	gas	600	Natl 50-A	600	9,000
T T Eason Co Div Eason Oil Co	12	gas	1000	Natl 80-B	1000	12,000
Fain-Porter Drlg Corp	4	gas	575	Emsco GB-500	600	8,000
Fleeger Drlg Inc	2	dsl	320	Wisn Roadair	700	8,500
Garr-Woolley Co	2	gas-btne	255	Emsco 350	378	7,000
	3	gas-btne	320	Emsco 500-GB	510	9,500
	4	gas-btne	320	Emsco 500-GC	510	9,500
Holliman Drlg Co	2	gas	350	Unit U-15	550	7,500
Slats Honeymon Drlg Co	2	gas-btne	450	Natl 80-A	—	12,000
Dave Morgan Drlg Co	—	LPG-gas	1050	Natl 80-B	800	10,000
O'Rourke-McGirl Drlg Corp	2	gas-btne	—	Unit U-15	800	8,000
Viersen & Cochran	2	gas	500	Natl 55	650	10,500
Sherin Drlg Co	5	gas-gaso	750	Natl 55	750	9,000
Coal County						
Sherin Drlg Co	4	gas-gaso	1000	Natl 100	1050	12,000
Sikes-Burckhalter	2	—	500	Wisn Atlas	750	10,000
Cotton County						
Crowe Drlg Co	2	gas	200	Natl T-12	175	4,000
Creek County						
Glenn Gillespie & Sons	2	gas-dsl	360	Wisn Mogul	280	6,000
	7	dsl	300	Frnks 658 TRD	225	4,000
Herring & Davis	2	gas-gaso	100	Mayhew 2000	100	2,000/2⅛"
	4	gas-gaso	150	Joy 200-A	150	2,000/2⅛"
Jonco Drlg Co	2	gas-btne	300	Brwstr N-3	200	4,500
Melco Drlg Co	2	btne	265	Brwstr N-35	185	5,000
Reed Drlg Co Inc	1	gas-gaso	220	Unit U-34	235	5,000
Sabre Drlg Co	4	gas-LPG	225	Brwstr N-3	160	3,500/4"
Scat Drlg Co	1	dsl	300	Emsco 300	—	5,500
	2	dsl	300	Wichtex R-6	—	5,500
Wade Drlg Co	1	dsl	225	Crdwll L	185	3,500
	3	dsl	325	Crdwll L	225	4,500
Dewey County						
Viersen & Cochran	7	gas	600	Wisn Titan	650	10,500
Garfield County						
Big Chief Drlg Co	27	gas	760	JS&G Spad Spr	760	9,000
Hayward Drlg Co	1	dsl-gas	165	Wilson	125	2,500
Lynn Drlg Co	4	gas-btne	300	Natl 50	675	8,000
Webster Drlg Co	6	gas-btne	600	Beth	600	7,500
Garvin County						
Dearing Inc	1	gas-btne	—	Natl 50	—	7,000
	2	gas-btne	—	Natl 100	—	15,000
	5	gas-btne	—	Wisn Giant	—	6,000
Flournoy-Haston Drlg Co	2	gas-btne	300	Unit U-15	650	8,500

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Goldsmith Drlg Co	2	—	400	Natl 50	—	8,000
Helmerich & Payne Inc	24	gas	850	Natl 80	1100	11,000
Holliman Drlg Co	4	gas	255	Unit U-15	500	7,500
Slats Honeymon Drlg Co	1	gas-btne	450	Natl 50-A	—	9,000
Johnson & Flesher Drlg Co	500	gas	600	Emsco GA-500	600	9,000
Kingery Drlg Co Inc	10	btne-gas	300	Wilson	375	4,500
Lewis & Mucher Drlg Corp	1	dsl	350	Emsco GA-500	650	8,500
Nichols Drlg Co	5	gas-btne	1350	Natl 75-CA	1350	11,000
Parker Drlg Co	5	gas	—	Natl L-50	700	9,000
	56	gas	—	Natl L-50	700	9,000
Perkins Bros Drlg Co	2	gas-btne	—	Unit U-15	675	8,500
Reading & Bates Inc	7	gas-btne	640	Natl 75	800	10,000
Sherin Drlg Co	1	gas-gaso	500	Unit U-15	600	8,000
Skipper Drlg Co	1	gas	325	Natl T-32	325	5,500
Viersen & Cochran	3	gas	600	Natl 75-CA	650	10,500
Chester H Westfall Drlg Co	1	gas-gaso	625	Unit U-15	700	10,400
Grady County						
A & P Drlg Co Inc	2	gas-gaso-btne	500	Emsco GB-500	500	8,000
Big Chief Drlg Co	29	gas	1875	Emsco 1250	1815	16,000
	30	gas	1545	Ideco 1050	1515	15,000
	35	gas	2610	Natl 110	2610	16,000
Falcon Seaboard Drlg Co	15	gas-btne	1100	Unit U-20	1200	16,000
	32	gas-btne	1050	Beth 650	—	16,000
Helmerich & Payne Inc	35	dsl	1100	Natl 110	1300	14,000
	44	gas	1200	"Oilwell" 96	1500	15,000
Viersen & Cochran	9	gas	1200	Emsco J-1250	1590	18,000
Dick Wegener Drlg Contr	4	gas	1900	Natl 130	1900	22,000
Grant County						
Barrett Pet Co	1	gas-gaso	—	Natl 50	450	6,800
	4	dsl	—	Unit U-10	350	5,800
Calvert Drlg Inc	15	dsl	260	Ideco H-35	260	5,000
Dudley & Heath Drlg Co	7	dsl	265	Brwstr N-4	320	5,500
O'Rourke-McGirl Drlg Corp	1	gas-btne	—	Unit U-10	450	6,000
Tennant Drlg Co	1	gas-btne	450	Frnks 6000	450	6,000
Viersen & Cochran	1	gas	325	Emsco G-300	450	5,800
	6	gas	255	Natl T-25	225	5,500
Harper County						
Beckman Inc	3 (wo)	gas	150	MIW P-42	175	10,000
Bryant-Hayward Drlg Co	1	gas	675	Natl 50	675	8,500
Calvert Drlg Inc	19	dsl	350	Unit U-15	600	8,500
T T Eason Co Div Eason Oil Co	15	gas	450	Emsco T-250	225	6,000
Garvey Drlg Co	6	dsl	275	Unit U-15	640	8,500
R W Rine Drlg Co	5	gas-btne	520	Brwstr N-55	550	7,500
Unit Drlg Co	2	gas-btne	900	Unit U-15	900	8,500
Viersen & Cochran	5	gas	500	Natl 50	650	9,000
Johnston County						
Nichols Drlg Co	2	gas-btne	700	Natl 55	700	12,000
Kay County						
Criswell Drlg Co	1	dsl	300	Unit U-34	300	4,500
Doak Drlg Co	3	btne-gas	270	Natl T-20	250	4,500
Folk Drlg Co	1	dsl	200	Crdwll RL	200	4,000
Foster Drlg Co	1	dsl	265	Natl T-16	265	5,000
Glenn Gillespie & Sons	3	dsl	425	Wisn Mogul	280	6,000
Dave Morgan Drlg Co	—	LPG-gas	350	Natl T-32	320	6,000
Target Drlg Corp	1	gas-btne	225	Unit U-34	195	5,000
Kingfisher County						
Nuckolls-Bell Drlg Co	2	dsl	300	Ideco H-40	352	7,500
	3	dsl	600	Ideco H-525	704	9,000
Kiowa County						
A & P Drlg Co Inc	1	gas-gaso-btne	450	Emsco G-450	450	7,000
General Drlg Co	5	—	300	Natl	—	7,000
Sherin Drlg Co	3	gas-gaso	500	Unit U-15	600	8,000
Lincoln County						
Barrett Pet Co	3	dsl	—	Wisn Giant	300	5,500
Dudley & Heath Drlg Co	6	dsl	265	Crdwll S	320	5,500
Lincoln Drlg Co	1	gas	250	Brwstr N-3	185	4,500
Wm A Norton	1	gas-btne	300	Unit U-10	370	6,000
Reed Drlg Co Inc	4	gas-gaso	300	Unit U-34	290	5,000
Seran & Howard Drlg Co	1	gas	225	Beth	200	5,000
Summit Drlg Corp	2	dsl	—	Frnks SAL 5000	800	5,000
Logan County						
Big Chief Drlg Co	1	gas	450	JS&G Spad "Super"	450	6,500
	24	gas	750	Unit U-15	800	9,500
Goff-Leeper Drlg Co	2	gas	225	Brwstr N-4	350	6,000
Sabre Drlg Co	3	dsl	285	Unit U-36	560	7,500/4"
Love County						
Arrow Drlg Co	18	gas	1260	Emsco 1250	—	14,000
Falcon-Seaboard Drlg Co	24	gas-btne	1050	Beth 950	—	16,000
Flournoy-Haston Drlg Co Inc	3	gas	600	Wisn Atlas	750	10,000
Ward S Merrick	1	gas	300	Wisn Giant	—	5,000
Nichols Drlg Co	9	gas-btne	700	Natl 50-A	700	10,000
Kidd Williams Drlg Corp	5	gas	825	Wisn Atlas	900	10,000
	6	gas	925	Wisn Titan	1000	15,000
	11	gas	775	Wisn Atlas	1200	12,500
Major County						
J S Montgomery	3	gas	1100	Natl 80	1100	12,000
Webster Drlg Co	4	gas-btne	650	Emsco 500	650	8,500
Marshall County						
T T Eason Co Div Eason Oil Co	14	gas	750	Emsco 6-B-500	750	9,000
McClain County						
Big X Drlg Co Inc	2	gas-gaso	750	Natl 55	750	10,000
Fain-Porter Drlg Corp	1	gas	750	Wisn Titan	900	11,000
Falcon Seaboard Drlg Co	28	gas	1200	Beth 650	—	16,000
Goff-Leeper Drlg Co	1	gas	800	Brwstr N-75	800	12,000
Holliman Drlg Co	5	dsl	825	Emsco GB-800	1000	11,000
Kerr-McGee Oil Ind Inc	41	gas	970	Natl 75	832	11,500
Parker Drlg Co	37	gas	—	Natl L-100	1400	14,000
	38	gas	—	Natl L-100	1000	14,000
Viersen & Cochran	8	gas	980	Emsco J-1000	975	14,000
Chester H Westfall Drlg Co	2	gas-gaso	625	Unit U-15	700	10,400
	3	gas-gaso	625	Unit U-15	700	10,400
Murray County						
Riceland Corp	4	gas	1200	Brwstr N-95	—	16,000
Noble County						
D J Branyan Co	1	dsl	600	Wichtex E-75	145	3,000
Chambless-Rosen Drlg Co	1	gas-btne	225	Crdwll RL	200	5,000
Goe Drlg Co	2	gas-btne	200	Wisn	145	3,250
Johnson & Flesher Drlg Co	—	gas	350	Frnks 6000	300	5,500
Lincoln Drlg Co	2	gas	325	Natl T-25	290	6,000
Pete Morris Drlg Co	2	dsl-gas	225	Unit U-34	225	5,000
Summit Drlg Corp	1	dsl	—	Emsco 450	480	7,000
Unit Drlg Co	1	gas-btne	290	Unit U-34	300	5,500
Nowata County						
Overby Drlg Co Inc	1	dsl-btne	180	Mayhew 1000	—	1,000
Okfuskee County						
Blackstock & Bradley Drlg Co	3	dsl	290	Crdwll	—	4,000
Sabre Drlg Co	2	dsl	330	Unit U-34	300	5,000/4"
Oklahoma County						
Calvert Drlg Inc	18	gas-btne	350	Unit U-15	600	8,500
N V Duncan Drlg Co	7	gas	250	Natl 50	450	7,500
Lynn Drlg Co	1	gas-btne	300	Natl 50	450	7,000
Parker Drlg Co	57	gas	—	Emsco 750	1000	10,000
Smiley & Little Drlg Co	4	gas	100	Wisn	100	2,600
Okmulgee County						
Mesker Drlg Co	2	gas	200	Joy 300	200	2,500
Smallwood & Son	1	gas-btne	145	Failing 1500	130	1,750
Twinoak Drlg Co	1	dsl	190	Frnks	190	3,500
Osage County						
Doak Drlg Co	2	btne-gas	270	Natl T-20	250	4,500
Falcon Seaboard Drlg Co	19	gas-btne	185	Unit U-34	—	5,000
Garr-Woolley Co	1	gas-btne	185	Emsco 300	280	5,500
Glenn Gillespie & Sons	1	gas	360	Unit U-34	225	4,500
	6	gas	290	Unit U-34	290	4,500
John Heard & Co Inc	2	gas-LPG	270	Natl T-12	212	3,500
R L Horn & Sons Drlg Co	1	dsl	285	Frnks Comet	300	5,500
Indian Drlg Co	1	btne	220	Ideco H-25	250	4,000
	2	dsl	220	Ideco H-35-S	350	5,000
Jackson Drlg Co	3	gas	400	Wisn Mogul	400	5,500
Al Johnson Drlg Co	1	btne	325	Mayhew	200	3,500
	2	btne	325	Mayhew	200	3,500
Johnson-Bates Drlg Co	1	gas	245	Unit U-34	300	4,500
Roy Lawrence Drlg Co	1	dsl	340	Frnks Comet	254	5,000
Mesker Drlg Co	1	gas	200	Joy 300	200	2,500
Pete Morris Drlg Co	1	dsl-gas	550	Wisn Giant	550	6,000
Peak Drlg Co Inc	14	gas-LPG	200	Brwstr N-35	200	4,000
Reed Drlg Co	3	gas-gaso	185	Wilson	145	2,800
Service Drlg Co	6	dsl	320	Brwstr N-4	—	4,500
	9	dsl	320	Natl	—	4,000
	11	LPG	185	Crdwll Trlrmt	125	2,500
Triad Drlg Co	3	gas-btne	250	Beth S-45	250	5,500
Pawnee County						
John Heard & Co Inc	1	gas-LPG	240	Brwstr N-4	212	3,500
Reed Drlg Co Inc	5	gas-gaso	275	Unit U-34	225	5,500
Pontotoc County						
Kingery Drlg Co Inc	3	dsl	210	Wilson	350	4,500
Pottawatomie County						
Johnson-Bates Drlg Co	2	gas	300	Unit U-34	300	5,000
Reed Drlg Co Inc	2	gas-gaso	—	Crdwll D	410	5,500
Seminole County						
Austin-Dunham Inc	1	gas-btne	350	Frnks SAL-6000	570	6,000
Austin Drlg Co	1	dsl	300	Unit U-34	300	5,500
Bodard Drlg Co	1	gas	225	Unit	185	4,500
Delaney Drlg Co	1	gas-btne	450	Unit U-15	450	7,500
	2	gas-btne	225	Unit U-34	225	5,000
Jonco Drlg Co	1	gas-btne	350	Emsco 160	250	5,500
Melco Drlg Co	1	btne	265	Brwstr N-35	185	5,000

Hi! since you are looking through this magazine, chances are you're going to drill a well...

...and

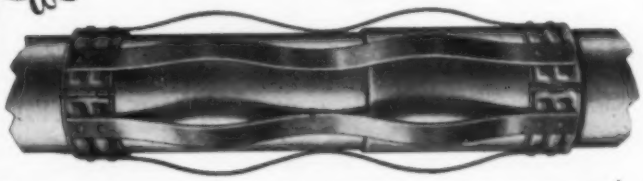
if you do, you are going to need dependable floating equipment...

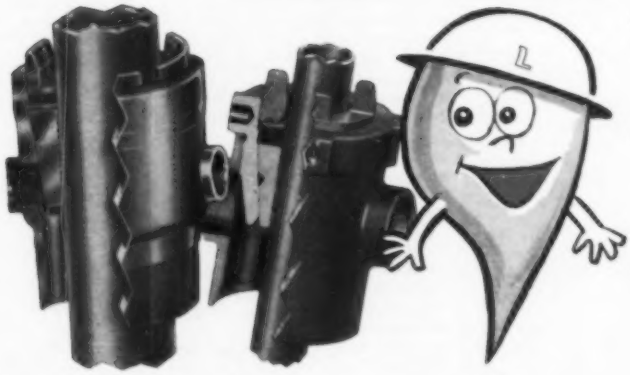
MAKE IT LARKIN.

...also

you'll need casing centralizers to help make sure of a good cement job.

MAKE IT LARKIN.





...and

if you are going to drill in an area of medium depths and pressure, you'll need a compact, dependable and economical casing head and tubing head.

MAKE IT LARKIN.

All Larkin Products are available "through your supply store"

LARKIN PACKER COMPANY, INC.
WAXAHACHIE, TEXAS

LARKIN ...Through Your Supply Store

LARKIN LEADERSHIP HAS BEEN EARNED BY YEARS OF DEPENDABLE PERFORMANCE

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Poteet Wysor & Eckles Inc	1	gas-btne	225	Unit U-34	185	5,000
R W I T Drlg Co	1	gas-LPG	150	Crdwll	150	3,000/3½"
Reed Drlg Co Inc	6	gas-gaso	240	Natl T-12	180	4,500+
Troup & Suttles Inc	2	gas-gaso	200	Wilson	370	5,000
Wolfe Drlg Co	5	gas-btne	735	Natl 50	735	7,500
	12	gas-btne	342	Natl T-20	342	4,500
Viersen & Cochran	13	gas	325	Natl T-16	175	5,200
Stephens County						
Bryant-Hayward Drlg Co	2	gas	675	Natl 50	675	8,500
	3	gas	700	Unit U-15	700	9,500
	4	gas	900	Brwstr N-75	900	12,000
C N P Drlg Co	1	gas	185	Wichtex	145	3,500
Crowe Drlg Co	1	gas	175	Wisn Super 38	175	4,000
R A Davenport Drlg Contr	2	gas-btne	145	Wichtex R-4	145	2,500
Falcon Seaboard Drlg Co	33	gas	1050	Beth 1013	—	16,000
Flournoy-Haston Drlg Co	4	gas-btne	700	Natl 1000	1000	14,000
Goff-Looper Drlg Co	3	gas	450	Unit U-15	450	8,000
Goldsmith Drlg Co	1	—	400	Unit U-15	—	8,000
Holliman Drlg Co	1	gas	500	Unit U-15	900	7,500
Jennings Drlg Co	5	btne-gas	450	Wisn Giant	900	9,000
Nelson Drlg Co	2	gas	620	Wisn Giant	620	7,500
Nichols Drlg Co	1	gas-btne	350	Wisn Giant	350	5,500
	4	gas-btne	450	Wisn Giant	450	7,500
	10	gas-btne	450	Wisn Giant	450	7,500
Parker Drlg Co	34	gas	—	Natl L-75	800	10,000
	60	gas-elec	—	Natl L-34x10	2000	2,500
Pierco Drlg Co	1	gas-LPG	400	Wisn Mogul	165	4,200
Viersen & Cochran	11	gas	1525	Natl 110	1530	18,500
Dick Wegener Drlg Contr	3	gas	350	Whind B-85	500	10,000
Kidd Williams Drlg Corp	10	gas	1400	Wisn Spr Titan	2100	21,000
Texas County						
Midwestern Drillers Inc	2	dsl	320	Unit U-15	600	7,500
Moran Bros Inc	11	dsl	300	Wisn Giant	350	5,000
Musgrove Petroleum Corp	3	dsl	440	Natl 50	—	5,500
Nye & Snell Drlg Co	2	dsl	320	Wisn M-46	320	5,000
R W Rine Drlg Co	3	gas-btne	520	Unit U-15	600	7,500
Tillman County						
Bolin Oil Co & D H Bolin	3	gas	350	Wisn Giant	225	5,000
E W Moran Drlg Co	1	gas	500	Unit U-15	560	7,500
Tulsa County						
Riceland Corp	2	gaso	—	Failing 1500	—	1,600/2⅛"
Washington County						
Herring & Davis	3	gas-gaso	150	Mayhew 2000	150	2,000/2⅛"
Overby Drlg Co Inc	3	btne	250	Mayhew 2000	250	2,000
Washita County						
Nichols Drlg Co	77	gas-btne	1530	Natl 110	1530	15,000
Reading & Bates Inc	2	gas-btne	1290	Natl 110	1650	15,000
Woods County						
Falcon Seaboard Drlg Co	8	gas-btne	450	Beth 450	—	10,000
Woodward County						
Arrow Drlg Co	11	dsl	595	Emsco 500	—	8,000
Big Chief Drlg Co	33	gas	1250	Natl 88	1250	11,000
Helmerich & Payne Inc	36	gas	500	Emsco GB-50052	700	9,000
Keating Drlg Co	15	gas-gaso	—	—	675	9,000
Nichols Drlg Co	8	gas-btne	650	Natl 50-A	650	9,000
OREGON						
Douglas County						
Green & Heiser Drlg Co	2	dsl	715	"Oilwell" 66	550	9,500
Jefferson County						
Colorado Wyoming Drlg Co	2	dsl	668	Natl 55	668	12,000
PENNSYLVANIA						
Clearfield County						
Delta Drlg Co	24	dsl	670	Emsco GC-500	500	8,500
	34	gas-btne	800	Unit U-15	600	8,000
	39	gas-btne	500	Natl 75	1000	9,500
Fairman Drlg Co	1	gas-btne	500	Beth M-58	600	10,000
	2	gas-btne	500	"Oilwell" 66	600	9,000
S W Jack Drlg Co	1	gas	635	Unit U-15	635	8,500
	3	gas	650	Unit U-15	650	8,500
	4	gas	1000	Unit U-15	1000	10,000
Lohmann-Johnson Drlg Co Inc	2	gas	500	"Oilwell" 76	750	10,000
Indiana County						
C J Simpson Drlg Co	2	gas-btne	—	Wisn Roadair	500	8,000
	4	gas-btne	—	Natl T-20	275	5,000
Potter County						
Delta Drlg Co	30	dsl	670	Emsco G-500	500	8,500
Westmoreland County						
Delta Drlg Co	10	dsl	560	Unit U-15	560	7,000
SOUTH DAKOTA						
Pennington County						
Branyan Drlg Co	1	dsl	600	Frnks 6000	600	6,000

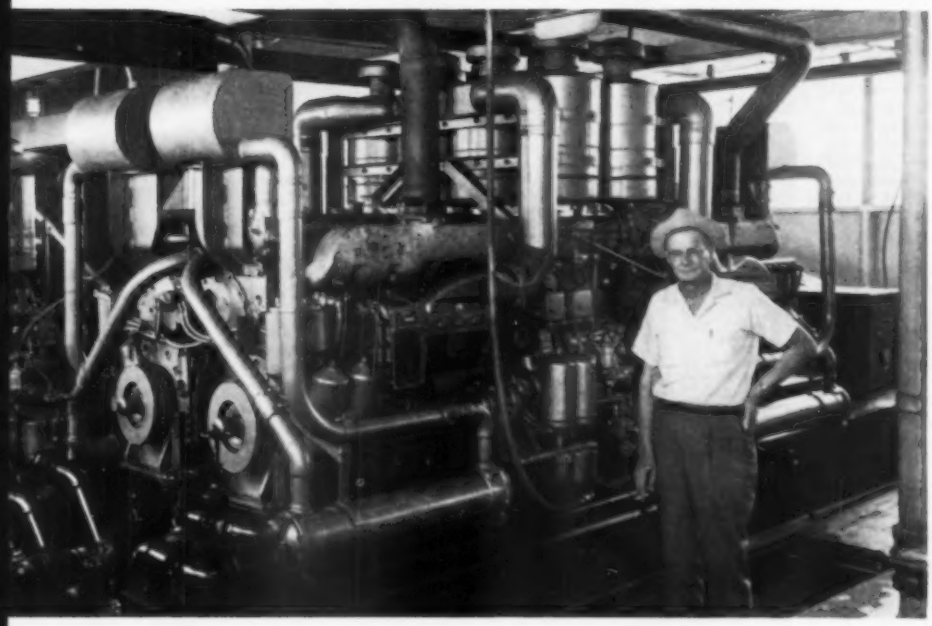
Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
TEXAS						
Anderson County						
Ace Drlg Co	2	gas	680	Emsco G-500	500	7,500
	3	gas	750	Natl 50-A	450	7,500
	4	gas	680	Emsco G-500	500	7,500
Harry Bass Drlg Co	103	stm	—	Emsco	—	14,000
Haynes B Ownby Drlg Co	3	dsl	—	Wilson	400	5,000
Trant Drlg Co	2	dsl	—	Ideco	—	12,000
Andrews County						
Arrow Drlg Co	17	gas	1260	Emsco 1250	—	14,000
B B M Drlg Co	1	gas-btne	950	Emsco GB-800	1050	14,000/4"
L E Bever Drlg Co	1	gas	225	Unit U-34	225	5,500
Big West Drlg Co	11	gas-btne	500	Unit U-20	900	14,000
Choya Drlg Co Inc	3	gas-btne	900	Beth MC-650	900	12,000
Davidson Drlg Co Inc	A	gas-btne	1000	Emsco J-1250	1000	14,000
M J Delaney Co	19	gas-btne	600	Emsco J-1250	1200	15,000
	27	gas-btne	500	Beth 450	850	11,000
	31	gas-btne	450	Wisn Gnt Rdr	650	7,000
The Denver Co	1	gas	335	Natl T-20	300	5,500
Donnell Drlg Co	6	gas-btne	975	Beth MC-450	975	10,000
	9	gas-btne	1400	Beth MC-950	1400	15,000
	10	gas-btne	650	Beth M-58	650	10,000
Fryer & Hanson Drlg Co	4	gas-btne	1150	"Oilwell" 76	1200	12,000
Great Western Drlg Co	27	gas-gaso	—	—	1125	15,000
	34	dsl	—	—	1200	10,000
O E Hall Drlg Co	5	gas	700	Unit U-40	1210	12,000
Helmerich & Payne Inc	41	gas	1200	Natl 110	1500	14,000
Hewgley Drlg Co	5	dsl	—	Emsco J-750	975	11,000
Keating Drlg Co	18	gas-gaso	—	—	1150	14,000
La Mance Drlg Co	2	btne	700	Unit U-15	—	9,500
Lee Drlg Co	6	gas-gaso	1050	"Oilwell" 76	—	13,000
Llano Drlg Co	2	gas	—	Natl 100	975	14,000
Loffland Bros Co	67	gas	970	—	1050	14,000
Lomax Drlg Co	111	gas-btne	850	Natl 75	850	10,500
Lowe Drlg Co	9	gas	2000	Natl 125	—	17,000
McQueen & Stout Drlg Co	9	LPG	225	Crdwll RL	185	4,500
Milhoan Drlg Co	3	gas	900	Beth 450	—	10,000
Parker Drlg Co	16	gas	—	Natl L-100	1400	14,000
	47	gas	—	Natl L-100	1400	14,000
Penrod Drlg Co	1	gas-btne	—	—	1800	15,000
	2	gas-btne	—	—	580	7,000
Rowan Drlg Co Inc	29	gas-btne	1200	Natl 100	1480	14,000
Sharp Drlg Co	20	gas	1350	Beth MC-950	1350	15,000
	32	gas	1200	Beth MC-450	1200	12,000
	36	gas	1350	Beth MC-950	1350	15,000
	41	gas	900	Beth MC-650	900	12,000
Southeastern Drlg Corp	1	gas	1200	"Oilwell" 96	1350	18,000
A W Thompson Inc	6	gas	600	Beth 450	1050	11,000
Westlund Drlg Co	1	gas-btne	600	Unit U-15	600	6,500
Aransas County						
Bilbo-Redding Drlg Co Inc	Bge 6	dsl	1050	"Oilwell" 76	—	12,500
C G Glasscock Drlg Co	10	dsl	750	Natl 90	—	9,000
Archer County						
Akin & Dimock	2	dsl	300	Beth S-55	420	7,000
Anderson Drlg Co	1	btne	225	Wisn Mogul	—	4,000
Ayers & Burch	3	btne	185	Wichtex	—	3,000
R W Darden Drlg Co	1	gas	145	Wichtex R-3	—	3,000
E & H Drlg Co	2	gas	275	Unit U-34	225	4,500
T V Gorman Drlg Contr	1	dsl	200	Wichtex R-3	200	3,000
O E Hall Drlg Co	2	gas	320	Unit U-15	700	8,000
Norwood Drlg Co	8	gas-gaso	300	Wisn	175	4,000
Revier Drlg Co	2	gas-btne	600	Wisn Giant	600	7,000
Atascosa County						
Buzzini Drlg Co	7	gas-btne	950	Wisn Atlas	930	11,000
Hunt Drlg Co Inc	4	gas	485	Emsco GB-250	306	7,000
Longhorn Drlg Co	6	gas-btne	500	"Oilwell" 76	1185	14,000
Austin County						
Henderson Drlg Corp	5	gas-btne	800	Natl 55	800	11,000
Baylor County						
Ayers & Burch	2	btne	145	Wikr-Nr	—	3,000
A D McDuffie	4	btne	165	Big Four	145	2,500
Meredith Drlg Co	1	btne	225	Wisn Super	145	3,500
E W Moran Drlg Co	3	dsl	285	Wisn Giant	650	7,500
Bee County						
Allen & Morris	3	stm	500	Emsco H-46M	1200	11,000/5"
Appell Drlg Co	3	gas-gaso	510	Brwstr N-4	225	5,500
Dan L Clark Drlg Co	5	gas-btne	780	Brwstr N-7	—	8,500
Dillingham Drlg Co	1	gas-btne	530	Wisn Giant	460	7,500
MIM Drlg Corp	1	dsl	500	Frnks SA-4500	300	5,000
Marvin S Ridgeway	—	gaso	—	Mayhew 1000	—	1,000/2⅛"
	—	gaso	—	Mayhew 1000	—	1,000/2⅛"
	—	gaso	—	Mayhew 1000	—	1,000/2⅛"

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Bexar County						
J E Hillier	1	dsl	400	Sullivan 300-A	200	4,000/3½"
Pegg Bros Drlg Co	1	gas-btne	145	Brwstr	145	4,500/3½"
Borden County						
Denver Drlg Corp	8	gas	825	Unit U-15	825	9,500
Hewgley Drlg Co	1	dsl	—	Emsco GA-500	650	8,500
Loffland Bros Co	142	gas	740	—	900	9,000
Marcum Drlg Co	2	gas-btne	500	Unit U-15	675	8,000
Brazoria County						
Bilbo-Redding Drlg Co Inc	4	gas-LPG	580	Wisn Giant	—	8,000
CBS Workover Co	3	gas-btne	300	Ideco H-30D	215	4,500
Dillard-Waltermire Inc	3	stm	800	Natl 23-9FM	1000	12,000
	4	stm	1200	Natl 34-10FE	1500	16,000
	5	stm	800	Natl 23-9FM	1000	12,000
C J Foster Drlg Co Inc	3A	stm	—	Emsco EB-54-4	1000+	18,000
Hunt Drlg Co Inc	2	stm	750	Emsco UBLS	1000+	10,500
	5	gas	450	Beth M-58	666	11,000
	7	stm	1000+	Emsco H46MA	750	10,500
Loffland Bros Co	56	stm	—	—	—	15,000
Penrod Drlg Co	14	gas-btne	—	—	756	10,000
Rowan Drlg Co Inc	4	gas-btne	900	Natl 75	1149	11,000
Brewster County						
Durham Drlg Co Inc	3	gas	1150	Unit U-20	1300	14,000
Brooks County						
Conroe Drlg Co	3	gas-btne	675	Unit U-15	675	9,500
Brown County						
Burger Drlg Co	1	gas	225	Wisn Mogul	185	4,000
Calhoun County						
Layton Brown Drlg Co	3	stm	—	—	1050	10,000
Crown Rigs Inc	Bge 2	dsl	1000	Beth MC-450	1000	11,500
C G Glasscock Drlg Co	7	gas	800	Unit U-15	—	9,000
Callahan County						
West Central Drlg Co	7	gaso-btne	225	Wisn Giant	250	5,000
Cameron County						
Bilbo-Redding Drlg Co Inc	8	gas-LPG	1600	Natl 110	—	12,000
Carson County						
Keating Drlg Co	6	gas-gaso	—	—	450	5,000
J R McGill	1	gas-gaso	—	Emsco	570	7,000
Moran Bros Inc	5	dsl	300	Wisn Giant	350	5,000
Schafer Drlg Co	6	gas-gaso	200	Unit U-34	200	5,000
Cass County						
South States Drlg Co	4	dsl	275	Emsco GA-350	480	7,000/4"
Chambers County						
Bilbo-Redding Drlg Co Inc	5	gas-LPG	900	Beth 450	—	11,000
	Bge 7	dsl	550	"Oilwell" 64-B	—	7,500
Brewster-Bartle Drlg Co Inc	9	dsl	—	"Oilwell" 96	1500	16,000
Edwards & Bissett Inc	1	gas-btne	800	Wisn Gnt Roadair	800	8,500
Houston Oil Well Serv Co	2	dsl	—	Wisn Titan	1000	10,000
Hunt Drlg Co Inc	3	gas	525	Emsco GB-350	443	8,500
Mac Drlg Co	7	stm	500	Natl 34-26	5000	10,000
Meadows & Walker Drlg Co	2	stm	1000	Alco BIW-12	1000+	12,000
Southworth & Wood Inc	1	gas-dsl	300	Crdwll TR-67	280	7,500
Cherokee County						
B G Byars Power Drlg Co	3	dsl	445	Emsco G-300	300	5,500
Gibson Drlg Co	3	gas-btne	300	Wisn Giant	275	6,000
Maxwell Herring Drlg Corp	1	gas	300	Wisn Mogul	400	6,000
Mustang Drlg Corp	2	gas-gaso	—	—	350	6,000
Trant Drlg Co	3	stm	—	—	—	15,000
Woolf & Magee Inc	7	gas-btne	800	Beth MC-450	800	11,000
Clay County						
Bolin Oil Co & D H Bolin	5	gas	225	Wisn Mogul	190	4,000
Jack Grace Drlg Co	17	gas-btne	370	Wisn Giant	700	8,000
Jennings Drlg Co	6	btne-gas	350	Brwstr	350	6,000
Cochran County						
Hissom Drlg Co	2	gas	400	Unit U-34	500	6,000
Western Drlg Co Inc	9	btne	500	—	500	5,000
	11	dsl	288	Emsco 350	375	6,500
Coke County						
Dual Drlg Co	3	gas	600	Beth M-58	600	10,000
Empire Drlg Co	2	gas	500	Brwstr N-7	675	9,500
Tex-Mex Drlg Co	7	gas	—	Emsco GB-350	—	7,000
Coleman County						
Dixon Drlg Co	4	dsl-gas	200	Natl T-12	200	4,000
Herb Expl Co	—	gas-gaso	—	Failing 1500	—	1,750/2½"
	—	gas-gaso	—	Failing 1500	—	1,500/2½"
Moore & Moore Drlg Co	5	btne	175	Unit U-34	210	5,000
Lamar H Moore Drlg Co	2	btne	250	Wisn Giant	480	7,000
Haynes B Ownby Drlg Co	2	gas-btne	—	Wilson	700	7,000
Colorado County						
Bilbo-Redding Drlg Co Inc	3	stm	1050	Emsco UBLS 54	1000+	12,500
	12	stm	900	Natl 34-8-½	1000+	11,000
Dillard-Waltermire Inc	7	stm	800	Natl 23-9FM	1000	12,000
Chet Whaley Well Serv Co	1	gas-gaso-btne	225	Wisn Giant	225	5,500/3½"
Concho County						
Tucker Drlg Co	2	gas	425	Brwstr N-4	—	6,500
Cooke County						
Alan Drlg Co	2	gas	350	Wisn Mogul	185	4,000
Brown & Martin Drlg Co	1	btne	230	Wisn Giant	215	5,500
	2	btne	150	Wilson	105	1,500
Felderhoff Bros Drlg Co	1	dsl	260	Wisn Mogul	220	4,700
Jack Grace Drlg Co	12	gas-btne	625	Wisn Atlas	1200	10,000
Roy Guffey Drlg Co	5	gas-btne	430	Unit U-34	260	5,500
Holliman Drlg Co	6	gas	750	Wisn Atlas	950	10,000
Gene McCutchin	8	gas	550	Natl 50	550	8,000
O'Neal Drlg Co	5	gas-gaso	—	Emsco GA-500	675	10,000
Russell & Russell Drlg & Prod Co	1	gas-gaso-btne	275	Wisn Giant	180	4,500
	2	—	—	Wisn Mogul	—	—
	3	—	350	Wisn Mogul	350	5,000
T & O Drlg Co	2	dsl	200	Wisn Super	130	3,500
Trachta Drlg Co	1	dsl	250	Wilson	185	3,000
Crane County						
Beckman Inc	1(wo)	gas	185	Unit U-15	350	6,000
Clark Dale Drlg Co Inc	3	gas	—	"Oilwell" 66	660	10,000
Davidson Drlg Co Inc	B	btne	630	Wisn Titan	900	10,000
Delta Drlg Co	4	gas-btne	800	Natl 100	800	12,000
Durham Drlg Co Inc	2	gas	500	Unit U-15	675	9,000
Gardner Bros Drlg Co Inc	6	gas-btne	500	Natl 75	700	10,500
	8	gas-btne	500	Unit U-15	675	7,000
	18	gas-btne	400	Natl 50	575	7,000
Great Western Drlg Co	38	gas-gaso	—	—	675	7,500
	40	gas	—	—	840	10,000
Guadalupe Drlg Co	1	gas-btne	700	Ideco M 1000	—	10,000
Helmerich & Payne Inc	42	gas	970	Natl 100	1000	13,000
Johnn Drlg Co	3	gas	650	Wisn Atlas	900	10,000
	7	gas	185	Brwstr N-4	300	5,500
Keating Drlg Co	16	gas-gaso	—	—	450	6,500
La Mance Drlg Co	5	btne	550	Unit U-15	550	7,500
Laughlin-Porter Drlg Co Inc	1	gas	800	Natl 50	—	7,000
	3	gas	416	Natl T-20	—	5,000
Lee Drlg Co	1	gas-gaso	700	Natl 50	—	8,000
	2	gas-gaso	700	Natl 50	—	8,000
	4	gas-gaso	700	Natl 75	—	10,000
	5	gas-gaso	1050	Natl 100	—	13,000
	7	gas-gaso	440	Beth S-55	—	6,000
Loffland Bros Co	140	gas	740	—	900	9,000
Marcum Drlg Co	4	gas-btne	325	Brwstr 55-W	450	6,000
	5	gas-btne	1000	Brwstr N-95	1525	14,000
McDaniel & Beecherl Drlg Co	10	gas-gaso	—	"Oilwell" 66	—	10,000
McQueen & Stout Drlg Co	11	LPG	225	Crdwll RL	185	4,500
O'Neal Drlg Co	3	gas-gaso	—	Emsco 450	450	6,500
	4	gas-gaso	—	Emsco GB-500	700	11,000
Parker Drlg Co	39	gas	—	Natl L-100	1400	14,000
Rowan Drlg Co Inc	22	gas-btne	600	Natl 50	766	7,000
B B Smith Inc	1	gas	600	Brwstr N-4	300	6,000/3½"
	2	gas	600	Unit U-15	450	7,000
Triad Drlg Co	1	gas-btne	500	Natl 50	500	7,000
Western Serv Drlg Co Inc	2	gas-btne	600	Natl 50-A	700	8,000
Crockett County						
Bolin Oil Co & D H Bolin	1	gas	225	Natl T-12	145	3,500
Coroco Drlg Co	1	gas-gaso	500	Beth 650	650	12,500
Frank Frawley Drlg Co	5	gas	—	Unit U-15	675	8,500
Hewgley Drlg Co	6	dsl	—	Emsco GB-500	650	9,000
Laughlin-Porter Drlg Co Inc	8	gas	—	Natl 75	700	900
Pool & Gerlich Drlg	D-1	gas	260	Unit U-34	300	5,000
Texita Oil Co	1	dsl	320	Emsco GA-250	300	6,500
	3	dsl	260	Beth	300	5,000
Crosby County						
Smith & Breyer	4	gas	530	Frnks	530	9,500
Dawson County						
Harry Bass Drlg Co	101	gas	850	Emsco	570	9,000
	115	gas	1200	Emsco	1200	12,000
Coroco Drlg Co	6	gas-gaso	400	"Oilwell" 66	500	9,000
Frank Frawley Drlg Co	3	gas	—	Natl 100	1050	13,000
J E Jones Drlg Co	1	gas	500	"Oilwell" 66	630	8,000
Keating Drlg Co	11	gas-gaso	—	—	650	8,500
Norwood Drlg Co	3	gas-gaso	1050	Wisn Titan	1050	12,500
Deaf Smith County						
Riceland Corp	3	gas	900	Brwstr N-75	—	10,000
De Witt County						
Appell Drlg Co	2	dsl	520	Frnks SG-101	400	7,000
Harkins & Co	6	gas-gaso	675	Unit U-15	675	9,500
	7	dsl	600	Unit U-15	600	8,500
J & C Drlg Co	2	stm	600+	Emsco H-46	700+	9,000
Mangum Drlg Co	2	stm	1400	Emsco ECC	1400	16,000
Dimmit County						
Sutton Drlg Co	3	dsl	300	Brwstr N-4	350	6,500

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Sutton Drlg Co	4	dsl	350	Brwstr N-4	875	6,500
	6	dsl	121	Alamo	225	5,000/2⅛"
Duval County						
Chiles Drlg Co	2	dsl	300	Ideco H-40	300	6,000
Field Drlg Co	4	dsl	520	Beth Breeze	260	5,500
General Well Drlg Inc	3	gas-btne	425	Beth	183	5,000
	8	gas-btne	500	Brwstr N-4	185	5,000
Harkins & Co	1	gas-gaso	555	Unit U-15	555	8,500
H H Howell Drlg Co	1	dsl	376	Frnks 5000	248	6,000
A J Kuenstler Drlg Co	1	dsl	300	Wisn Giant	300	7,500
Rhodes & Hicks Drlg Corp	1	gas-btne	370	Frnks 137	200	5,500
Viking Drlg Co	4	gas-gaso	450	Unit U-10	500	8,500
Eastland County						
Gore Drlg Co	2	dsl	320	Beth	—	5,000
Irish Drlg Co Inc	3	btne	285	Wisn Mogul	—	4,000
Frank Raiborn Drlg Co	1	gas	225	Wisn Mogul	186	4,000
Ector County						
Arrow Drlg Co	24	dsl	1200	Emsco 1000	—	14,000
B B M Drlg Co	9	gas-btne	1300	Unit 30	1800	18,000
Robert M Bass Drlg Contr	3	gas-LPG	400	Wisn Gnt Roadair	600	8,500
Beckman Inc	2(wo)	gas	185	Beth S-50	185	3,500
	11(wo)	gas	300	Unit U-34	300	4,500
Brantly Drlg Co Inc	1	gas	365	Emsco 500	500	9,000
	2	gas	975	Emsco 800	1000	14,000
	4	gas	375	Beth S-55	480	6,500
	6	gas	400	Natl 80	750	9,000
	7	gas	675	Beth 450	1125	12,500
Capitan Drlg Co	2	gas	450	Emsco G-450	450	7,000
Choya Drlg Co	1	gas	500	Emsco GB-500	550	8,500
	5	gas-btne	460	Emsco GB-350	460	6,500
Sam E Crump Drlg Co	1	gas	—	Unit U-15	650	8,500
Davidson Drlg Co Inc	C	btne	660	Emsco GC-500	660	8,500
	D	btne	315	Wisn Giant	600	7,500
M J Delaney Co	26	stm	—	Natl T-38	—	15,000
	30	gas-btne	500	Beth 1013	1200	15,000
Delta Drlg Co	2	gas-btne	400	Natl 50	450	7,000
	36	gas-btne	900	Wisn Titan	900	15,000
Dillard-Waltermire Inc	12	gas	600	Wisn Giant	800	8,000
	14	gas	600	Wisn Giant	800	8,000
	16	gas	500	Natl 50	700	6,500
Dixilyn Drlg Corp	4	gas	950	Natl 80	950	14,000
Eastland Drlg Co	2	gas	—	—	540	7,500
	4	gas	—	—	190	4,500
Exploration Drlg Co	14	gas	800	Natl 75-CA	900	11,000
Frisbie Drlg Co	1	btne	450	Unit U-15	450	8,000/3½"
Gardner Bros Drlg Co Inc	5	gas-btne	500	Natl 75	675	9,000
	16	gas-btne	1000	Natl 125	1400	15,000
Helmerich & Payne Inc	48	gas-btne	1500	Natl 110	1600	13,000
Hewgley Drlg Co	4	dsl	—	Emsco GA-500	650	8,500
Highland Drlg Co	1	gas	—	Natl 50	550	8,200
	2	gas	325	Ideco H-35	375	5,600
Carl B King Drlg Co of Tex	5	gas-gaso	1000	Natl 100	1000	13,500
Milestone Drlg Co	100	dsl	550	Ideco H-525	600	7,500
Milhoan Drlg Co	7	gas	600	"Oilwell" 76	—	8,000
Norwood Drlg Co	2	gas-gaso	600	Wisn Atlas	900	10,500
	4	gas-gaso	500	Wisn Gnt Rdair	600	9,500
Parker Drlg Co	32	gas	—	Natl 50	700	9,000
	43	gas	—	"Oilwell" 96	1400	15,000
	58	gas	—	Natl L-100	1400	14,000
	59	gas	—	Natl 75	1000	11,000
Rowan Drlg Co Inc	16	gas-btne	504	Natl 50	660	7,000
Schoenfeld-Hunter-Kitch Drlg Co	7	LPG-gas	—	Natl 110	1200	16,000
	9	LPG-gas	—	Natl 75	900	11,000
	10	LPG-gas	300	Beth Twister	300	7,500
Darrell W Smith Co	1	dsl	470	Crdwll D	470	6,000
Ray Smith Drlg Co	2	btne	350	Natl 50	600	7,500
A W Thompson Inc	1	gas	1500	Emsco A-1500	1800	18,000
Tullous Drlg Co	1	dsl	250	Emsco 250	340	5,000
Warton Drlg Co	2	gas	600	Natl 50	700	8,500
Fayette County						
Hamman Oil & Ref Co	6	dsl	250	Brwstr N-4	310	6,500
Sutton Drlg Co	7	dsl	121	Alamo	225	5,000
Fisher County						
Drillers Inc	U-15	dsl	—	Unit U-15	600	7,200
Dual Drlg Co	6	gas	250	Emsco GA250T	300	5,000
Empire Drlg Co	9	dsl	600	Wisn Giant	600	7,500
Moore & Moore Drlg Co	6	btne	300	Unit U-15	636	9,000
Triad Drlg Co	2	dsl	300	Beth S-45	300	6,000
	4	gas-btne	400	Unit U-34	400	6,500
Wes-Tex Drlg Co	1	btne	338	Unit U-10	326	7,500
	3	btne	225	Crdwll B	326	6,500
Foard County						
E W Moran Drlg Co	2	gas	500	Wisn Giant	650	7,500

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Fort Bend County						
Columbia Drlg Co	5	dsl	400	Unit U-15	—	7,500
C J Foster Drlg Co Inc	9	gas-LPG	—	Wisn Giant	412	8,000
Frio County						
Milam Drlg Co	1	gas	500	Emsco G-500	500	7,500
Gaines County						
B B M Drlg Co	2	gas-btne	1100	Emsco GB-800	1050	14,000/4"
	5	gas-btne	450	Emsco J-750	650	12,000/3½
	6	gas-btne	400	Emsco GB-500	650	10,000/3½"
Harry Bass Drlg Co	112	gas	1200	Emsco	1200	12,000
M J Delaney Co	29	gas-btne	500	Beth 450	750	11,000
Dual Drlg Co	4	gas	600	Beth 450	600	11,000
Great Western Drlg Co	2	gas-gaso	—	—	840	9,000
	17	gas-gaso	—	—	1260	15,000
O E Hall Drlg Co	3	gas	320	Unit U-15	700	8,000
Helmerich & Payne Inc	39	gas	1100	"Oilwell" 96	1300	14,000
Johnn Drlg Co	4	gas	375	Unit U-15	600	8,500
Laughlin-Porter Drlg Co Inc	5	dsl	1080	Natl 23-9FEB	—	12,000
Chas E Long Jr Inc	3	dsl	400	Emsco GA-500	520	10,000/3½"
Lowe Drlg Co	11	gas	1250	Natl 100	—	12,500
Makin Drlg Co	6	gas-gaso	650	Wisn Giant	600	6,700
Marcum Drlg Co	3	gas-btne	500	Emsco GA-500	700	9,000
Moran Oil Prod & Drlg Corp	1	gas	—	Unit U-15	800	8,500
	3	gas	—	Unit U-15	800	8,500
Parker Drlg Co	28	gas	—	Natl L-50	700	9,000
	33	gas	—	Natl 75	1000	11,000
	53	gas	—	Natl 75	1000	11,000
Rowan Drlg Co Inc	25	gas-btne	1260	Natl 100	1680	14,000
Sharp Drlg Co	40	gas	1350	Beth Tornado	1350	14,000
Tri-Service Drlg Co	6	gas	1350	"Oilwell" 96	1350	16,000
Goal Tullous & Co	1	gas	500	Emsco J-750	1050	10,000
Warton Drlg Co	4	gas	700	Emsco J-750	1000	12,000
Westlund Drlg Co	5	gas-btne	650	Natl 50	—	7,500
Galveston County						
B B M Drlg Co	3	stm	—	Emsco UBLS-54-10	—	14,000
Edwards & Bissett Inc	3	gas-btne	1100	Brwstr N-75	800	10,500
Penrod Drlg Co	17	dsl	—	—	1464	14,000
	18	stm	—	—	—	15,000
Garza County						
Calco Drlg Co	3	gas-btne	275	Emsco GB-250T	250	5,500
Slim Rea Drlg Co	1	dsl	275	Brwstr N-4	—	6,000
Smith & Breyer	2	gaso	—	Cooper	—	3,000
	3	btne-dsl	355	Spencer	355	4,250
Glasscock County						
Carl B King Drlg Co of Tex	11	gas-gaso	900	Natl 75	900	11,000
Goliad County						
Harkins & Co	2	dsl	300	Wisn Giant	300	6,000
J E Hillier	2	dsl	400	Ideco H-40	400	7,000
Miller Bros & Bowling	3	gas-btne	850	Emsco GC-500	—	9,000
Viking Drlg Co	1	dsl	475	Natl 50	500	8,500
	3	gas-gaso	500	Unit U-15	600	9,000
Gonzales County						
Allen & Morris	5	pwr	1100	"Oilwell" 76	780	12,000
Gray County						
Beckman Inc	12(wo)	gas	150	MW P-42	175	10,000/2⅛"
Cree Drlg Co Inc	2	gas-btne	255	Unit U-10	360	4,500
	6	gas-btne	255	Wisn Giant	300	5,000
Hills & Hills Drlg Co	1	gas-btne	500	Emsco GB-350	—	6,500
Holt Bros Drlg Co	2	gas-btne	540	Ideco H-20	—	4,000
Moran Bros Inc	4	gas	1100	Wisn Titan	1300	15,000
Murphy & McKernan	1	dsl	390	Unit U-15	375	7,500
Schafer Drlg Co	7	gas-gaso	200	Ideco H-35	200	5,000
Tommy Ward Drlg Co	1	gas-btne	300	Unit U-35	426	7,000
	3	gas	350	Brwstr N-35	650	5,000
Grayson County						
Big Chief Drlg Co	5	gas	1545	Emsco 1250	1545	15,000
Roy Guffey Drlg Co	2	gas-btne	520	Unit U-15	520	7,500
E W Moran Drlg Co	5	gas	370	Natl 50	650	7,500
Norwood Drlg Co	1	gas-gaso	350	Wisn Gnt Rdair	600	8,500
Gregg County						
Cook Drlg Co	17	gas-btne	670	Wisn Atlas	650	10,000
Maxwell Herring Drlg Corp	8	gas	300	Wisn Mogul	250	4,500
Hansford County						
Baker & Taylor Drlg Co	1	dsl	800	Unit U-15	800	8,000
	2	dsl	800	Unit U-15	800	8,000
	8	gas	600	Emsco G-500	600	8,500
Cree Drlg Co Inc	4	gas-btne	350	Emsco GA-500	600	9,000
Helmerich & Payne Inc	26	gas	500	Emsco GB-500	700	9,000
Midwestern Drillers Inc	7	dsl	370	Unit U-15	750	8,500
Moran Bros Inc	6	gas	700	Wisn Giant	750	10,000
Rowan Drlg Co Inc	10	gas-btne	1020	Beth 450	766	9,000
Sojourner Drlg Corp	1	btne	218	Unit U-15	—	7,500

DEPENDABLE POWER



This is the Stewart & Stevenson GM Diesel 6-110 Quad and a man who knows his power — Joe E. Hellman, drilling superintendent for Glasscock Drilling Company

ECONOMY, LONG LIFE AND POWER—FROM 6-110 QUAD

What does a drilling superintendent look for in rig power? Ample power, of course . . . but economy of operation and long life, too. And these are the qualities found by the Glasscock Drilling Company on its Rig No. 14.

Joe E. Hellman, drilling superintendent for the company, says: "Glasscock now operates approximately 220 GM Diesel engines on drilling rigs and for other marine applications. Our company has standardized on GM Diesels because of their obvious economy, long life and good service rendered by Stewart & Stevenson Services, Inc."

On Glasscock Rig No. 14, a Stewart & Stevenson GM Diesel 6-110 Quad provides a 1000 H.P. wallop for the Gardner-Denver GP-GXR-H Mud Pump. There's power to spare.

The new 6-110 Quad develops 880 to 1000 continuous H.P., or up to 1200 intermittent H.P.

It couples POWER AND ECONOMY.

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We're proud of our record in meeting every power need for the nation's leading drilling contractors

THE WORLD'S LARGEST DISTRIBUTOR OF DIESEL ENGINES

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Hardin County						
Clegg & Hunt	2	stm	—	Emsco H-54	—	11,000
Lusk Drlg Co	12	gas	1360	Beth M-810	1000	12,500
Robinson-Wehmeyer Drlg Co	1	gas-btne	450	Unit U-34	225	6,000
Harris County						
Admiral Drlg Co Inc	G	dsl	650	Beth M-58	300	9,500
Bilbo-Redding Drlg Co Inc	11	gas-LPG	325	Unit U-34D	290	5,500
Coastal Marine Drlg & Constr Co	2	dsl-btne	925	Ideco 800	600	9,000
Columbia Drlg Co	2	gas	600	Natl 75	—	11,500
Comet Drlg Co	3	stm	900	Ideco Jr Gnt	—	10,000
Edwards & Bissett Inc	6	gas-btne	600	Ideco H-40D	500	7,000
Hill Drlg Co	1	dsl-gas-btne	700	Unit U-35	370	8,000
Holmes Drlg Co	7	gas-gaso	—	Beth MC-450	1000	11,000
Housh Drlg Co	1	stm	900+	Natl	1000+	12,000
	2	stm	900+	Natl	1000+	12,000
	3	stm	800+	Emsco UBLS	800+	10,000
	5	stm	600+	Emsco UBLS	600+	8,000
	6	stm	600+	Emsco UBLS	600+	8,000
	7	stm	600+	Emsco UBLS	600+	8,000
	8	stm	600+	Emsco UBLS	600+	8,000
	9	gas	435	Unit U-34	300	5,000
	10	gas-btne	1100	Ideco H-750	900	10,000
Lusk Drlg Co	14	gas	600	Crdwll Trlr	380	6,500
Lubie Martin Drlg Co	1	gas	300	Brwstr N-4	400	6,000
Haynes B Ownby Drlg Co	1	gas-btne	—	Unit U-900	—	9,500
Triton Drlg Co Inc	8	gas	800	Unit U-15	800	10,000/4"
W L B Drlg Co	1	gas-gaso-btne	350	Brwstr N-35	165	3,500
Chet Whaley Well Serv Co	2	gas-gaso-btne	225	Wlsn Giant	275	5,500/3½"
Harrison County						
Barnwell Drlg Co Inc	7	dsl	600	Brwstr N-75	600	10,000
	11	dsl	800	Wlsn Roadair	600	12,000
	34	dsl	800	Unit U-34	380	7,000
	45	dsl	800	Brwstr N-45	380	8,000
Robert M Bass Drlg Contr	4	gas-LPG	300	Wlsn Giant	300	5,500
Nowery Drlg Co Inc	2	dsl	6000	Unit U-15	600	8,000
Penrod Drlg Co	3	dsl	—	—	730	9,000
	7	dsl	—	—	730	9,000
Wheless Drlg Co	3	gas-btne	600	Emsco GB-350	600	7,500
Hartley County						
Urice Drlg Co	5	gas-btne	560	Wlsn Giant	560	8,000
Haskell County						
Ace Drlg Co	1	gas	680	Emsco G-500	500	7,500
Drill Well Oil Co	1	btne	185	Wlsn Super	—	4,000
B A Duffy Drlg Co	1	dsl	675	Frnks 3172	675	7,500/3½"
Hale Bros Drlg Co	2	gas	—	Wlsn Giant	—	6,500
W B Omohundro	4	btne	450	Wlsn Atlas	—	6,000
Hemphill County						
Baker & Taylor Drlg Co	7	gas-btne	1000	Natl 55	1000	10,500
Cree Drlg Co Inc	5	gas-btne	825	Unit U-40	975	14,000
Henderson County						
Maxwell Herring Drlg Corp	2	gas	700	Wlsn Gnt Rdair	700	10,500
W B Hinton	3	dsl	—	Unit	—	1,200
Ruhl Drlg Co Inc	1	—	475	Brwstr N-7	625	8,500
Hidalgo County						
Clark Fuel Prod Co	1	dsl	260	Natl T-8-S	140	2,500
Fitzpatrick Drlg Co	1	stm	800+	Ideco	1000+	12,000
	3	dsl	775	Brwstr N-7	700	8,500
	4	gas	1050	Beth Tornado	1000	13,000
General Well Drlg Inc	7	dsl	650	Crdwll	300	6,500
Gilmour Drlg Co	1	gas	500	Wlsn Gnt	300	6,000
Harrell Drlg Co	3	gas	700	Unit U-15	700	8,500
Hugh Kirkpatrick Inc	1	gas	696	TIW 5	712	8,000
	2	gas	1080	Natl 55-A	600	10,000
Schimmel Drlg Co	1	dsl	350	Wlsn Gnt Torcair	450	7,500
Viking Drlg Co	2	dsl	475	Natl 50-A	500	8,500
Hockley County						
Arrow Drlg Co	22	dsl	1200	Emsco 1000	—	14,000
Dual Drlg Co	2	dsl	400	Beth S-55	400	6,500
Great Western Drlg Co	37	gas-gaso	—	—	1200	10,000
Carl B King Drlg Co of Tex	7	gas-gaso	1000	Natl 100	1000	13,500
Livermore Drlg Co	2	gas	500	Wlsn Atlas	650	10,000
	3	gas	600	Natl 75	680	10,000
Western Drlg Co Inc	21	btne	650	Natl 100	325	10,000
Hopkins County						
Pyburn Drlg Co	2	gas	250	Wilson	800	9,000
Howard County						
Capitan Drlg Co	1	gas	700	Emsco GC-500	700	10,000
Maxwell Drlg Co	1	btne-gas	220	Brwstr N-4	220	5,500/3½"
Pool & Gerlich Drlg	D-5	gas	260	Natl T-12	200	3,500
Thomas & Billups Drlg Co	1	btne	550	Unit U-15	590	8,000
C D Turner Drlg Co	1	dsl	—	Brwstr N-4	—	5,500
Wes-Tex Drlg Co	5	btne	276	Natl 50	588	8,500
Hunt County						
M J Delaney Co	28	gas-btne	500	"Oilwell" 96	1000	14,000

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Hutchinson County						
Blackstock & Bradley Drlg Co	2	gas	325	Crdwll	—	4,000
Canadian River Drlg Co	1	dsl	300	Unit U-34	300	6,000
Drlg & Expl Co of Delaware Inc	24	gas	225	Wgnr Mrhse	400	5,000
	25	gas	225	Frnks 137/33 DTDX	400	5,000
Graham-Michaelis Drlg Co	5	dsl	275	Crdwll B	275	4,000
Kerr-McGee Oil Ind Inc	34	dsl	300	Frnks LTX-5000	300	5,000
Service Drlg Co	1	dsl	320	Unit U-34	—	4,500
	2	LPG	300	Unit U-34	—	4,500
	10	LPG	250	Unit U-34	—	4,000
Wagner & Wyant Drlg Co Inc	1	dsl	300	Unit U-15	450	8,000
Irion County						
McQueen & Stout Drlg Co	10	LPG	225	Crdwll RL	185	4,500
Pool & Gerlich Drlg	D-4	gas	260	Natl T-20	400	6,000
Jack County						
Fleeger Drlg Inc	5	dsl	360	Frnks	500	5,000
Jack Grace Drlg Co	19	gas-btne	255	Wlsn Giant	350	5,000
Lin-Mour Drlg Co	1	gas	315	Wlsn Mogul	400	4,600
Paine Drlg Co	7	dsl	450	Wlsn Giant	450	7,000
Revier Drlg Co	3	gas-btne	350	Brwstr CRB	290	4,500
Ward Drlg Co	2	btne	300	Wlsn Giant	600	5,000
Wright Clark & Senkel Inc	18	gas-btne	450	Wlsn Gnt Rdmstr	450	7,500
Jackson County						
CBS Workover Co	2	gas-btne	145	Crdwll K	145	2,500
Conroe Drlg Co	2	gas-btne	675	Unit U-15	675	9,500
Field Drlg Co	1	dsl	1040	Natl 50-A	520	8,500
Mac Drlg Co	5	gas-gaso-btne	275	Beth S-45	450	5,000
Mangum Drlg Co	3	gas-gaso	500	Unit U-15	700	9,200
	4	gas-gaso	450	Wlsn	450	6,500
Meadows & Walker Drlg Co	1	gas-btne	875	"Oilwell" 66	828	10,500
	3	gas-btne	900	Unit U-15	675	8,500
Jefferson County						
Chessher Sutton & Davis Drlg	2	gas-btne	1100	"Oilwell" 76	1200	11,500
Clegg & Hunt	3	dsl	—	Wlsn Titan 56	800	11,500
	9	btne-gas	—	Natl 50-A	—	9,500
Henderson Drlg Corp	4	gas-btne	1000	Natl B-80	1000	12,500
Kilroy Drlg Co	4	gas	450	Ideco 7-11	1200	12,000
Lake Drlg Co	1	gas-LPG	370	Wlsn Giant	—	5,800
	2	gas-LPG	180	Allis Chmrs	—	1,800
Meredith & Co	1	gas-gaso-btne	—	Emsco G-500	680	9,500
	3	gas-gaso-btne	—	"Oilwell" 96	1150	13,000
Jim Wells County						
Chiles Drlg Co	3	dsl	400	Ideco H-40-D	460	7,500
General Well Drlg Inc	1	pwr	450	Unit U-34	200	5,500
Stice Drlg Co	1	btne-gas	496	Unit U-15	—	7,500
Turnbull & Zoch Drlg Co	7	gas-btne	630	Ideco Rambler	630	10,000/3½"
Jones County						
Fryer & Hanson Drlg Co	10	gas-btne	225	Unit U-34	275	4,500
Hack Drlg Co	4	btne	—	—	161	2,500
Johnson-Gadbois Drlg Co	2	gas	230	Natl T-20	—	5,500
J E Miller Drlg Contr	1	btne	165	Natl T-8-S	145	3,400/3½"
Sojourner Drlg Corp	2	dsl	320	Unit U-15	—	5,000
	4	btne	225	Unit U-34	—	4,500
	5	btne	225	Natl T-8-S	—	3,250
Kaufman County						
Halbert Drlg Co	2	gas-btne	285	Wlsn Roadair	445	6,500
Walters Drlg Co Inc	14	gas	—	Mayhew 1000	150	400/2⅛"
Kenedy County						
Del Mar Drlg Co	1	stm	800+	Alco BIW 12	1000	11,000
C G Glasscock Drlg Co	8	dsl	1200	Natl 75	—	12,000
Holmes Drlg Co	3	gas-gaso	—	Natl 110	1500	16,000
Kent County						
Edgar Davis Drlg Co	12	gas-btne	650	Wlsn Giant	675	10,000
Hack Drlg Co	3	btne	—	Unit U-15	412	8,500
Rheay & Reynolds Drlg Co	6	gas	300	Wlsn Giant	750	5,000
King County						
West Central Drlg Co	5	gaso-btne	325	Unit U-15	600	7,500
Kleberg County						
Conroe Drlg Co	1	stm	1300	Natl 34-10FE	1000	15,000
J & C Drlg Co	8	gas-btne	800	Beth 650	800	12,000
Knox County						
Abb Drlg Co	1	gas	185	Wlsn Super	145	2,500
	2	gas	200	Wlsn Mogul	165	3,500
Bolin Oil Co & D H Bolin	9	gas	185	Wlsn Super	145	4,000
T V Gorman Drlg Contr	2	dsl	300	Wlsn 38 Torcair	300	4,500
Norwood Drlg Co	6	gas-gaso	650	Wlsn Titan	900	12,000
Reagan Drlg Co	1	btne	225	Wlsn Giant	187	5,500/3½"
R Benton Ross Inc	1	dsl	210	Wilson	165	3,100
Lamb County						
Livermore Drlg Co	4	gas	300	Wlsn Giant	350	5,000
Western Drlg Co Inc	17	btne	440	Crdwll L	145	4,000
La Salle County						
Longhorn Drlg Corp	5	gas-btne	450	Unit U-15	675	9,000

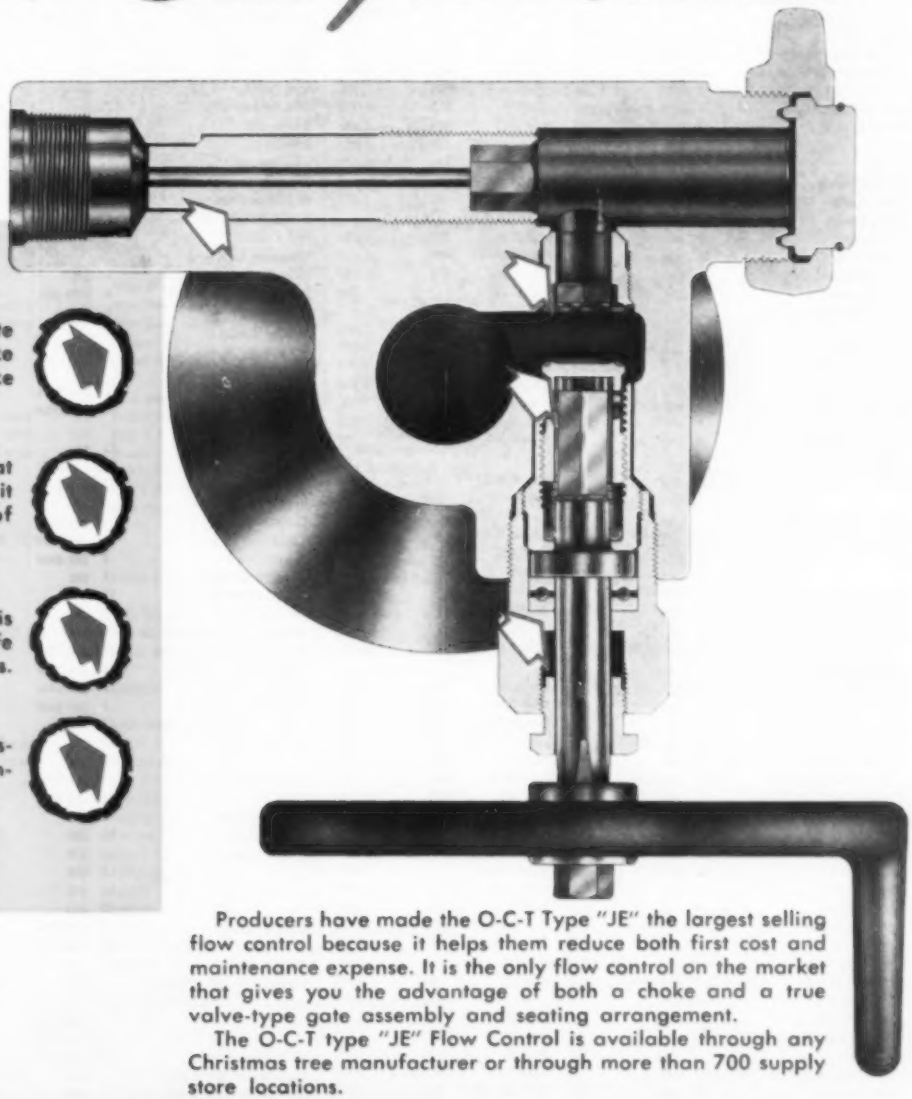
Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Lavaca County						
W P Taylor Drlg Co	3	gas	—	Natl	900	11,000
Lee County						
Carl B King Drlg Co of Tex	12	gas-gaso	1000	Natl 75	1000	12,500
Leon County						
Maxwell Herring Drlg Corp	4	gas	600	Wisn Gnt Rdair	600	8,000
Liberty County						
Admiral Drlg Co Inc	F	gas-LPG	700	Wisn Gnt	350	8,500
C J Foster Drlg Co Inc	6	gas-LPG	—	Frnks H-37	260	6,000
	8	gas-LPG	—	"Oilwell" 64-A	366	8,000
Gilger Drlg Co	1	gas-btne	1450	Natl	1450	13,000
	2	gas-btne	600	Beth 400	400	7,500
Holmes Drlg Co	1	gas-gaso	—	Beth ML-450	1000	11,000
Houston Oil Well Serv Co	4	gas-btne	—	Ideco M-10,000	855	10,000
	5	stm	1000+	Natl	1000+	12,000
Carnes W Weaver Drlg Co	5	gas-btne	465	Unit U-34	—	5,000
	6	gas-btne	540	Brwstr N-7	—	8,500
Lipscomb County						
Arrow Drlg Co	1	gas	860	Ideco 1000	—	11,500
Baker & Taylor Drlg Co	5	gas-btne	1650	Natl 110	1650	15,000
Dillard-Waltermire Inc	15	gas	800	Wisn Atlas	1200	11,000
Jack Grace Drlg Co	16	gas-btne	1020	Wisn Titan	1200	12,500
Lynn Drlg Co	3	gas-btne	1000	Natl 75	1000	11,500
Moran Bros Inc	1	gas	1050	Wisn Titan	1150	14,000
Rowan Drlg Co Inc	2	gas-btne	840	Natl 75	1120	11,000
	31	gas-btne	900	Natl 75	1149	11,000
Triad Drlg Co	6	gas-btne	600	Beth M-58	600	10,000
Webster Drlg Co	3	gas-btne	650	Wisn Atlas	650	10,000
	8	gas-btne	1050	Ideco 7-11	1050	12,000
Live Oak County						
Beard Drlg Inc	1	gas-btne	685	Wisn Giant	250	6,000
Buzzini Drlg Co	5	gas-btne	900	Wisn Gnt	712	10,000
Harkins & Co	4	gas-gaso	700	Wisn Giant	700	9,500
Longhorn Drlg Corp	3	stm	—	Emsco H-40	—	10,000
Turnbull & Zoch Drlg Co	1	stm	1600	Emsco	1000+	16,000
Loving County						
Leatherwood Drlg Co	1	gas	600	Ideco 750	—	10,000
	2	gas	440	Natl T-32	—	7,000
Lubbock County						
Lloyd R French Co	3	gas-btne	650	Natl 50	600	7,500
Western Drlg Co Inc	6	dsl	600	—	290	6,000
	18	btne	450	Crdwll 0	225	8,000
Madison County						
Trant Drlg Co	1	dsl	—	Unit U-15	—	9,000
Marion County						
Arrow Drlg Co	14	gas	600	Wisn	—	8,000
Delta Drlg Co	15	gas-btne	530	Unit U-15	600	8,000
Greyhound Drlg Co Inc	1	dsl	300	Brwstr N-4	280	5,500
South States Drlg Co	2	dsl	275	Emsco GB-350	450	6,000
Martin County						
Zephyr Drlg Corp	10	dsl	1260	Beth Tornado	1250	15,000/4"
Matagorda County						
Bilbo-Redding Drlg Co Inc	9	stm	1050	Emsco ECC	1000+	15,000
Harry T Bryant Drlg Co Ltd	4	gas-btne	900	Natl 75	900	12,000
C J Foster Drlg Co Inc	2	gas-LPG	—	Brwstr N-75	834	11,000
Henderson Drlg Corp	3	gas-btne	700	Natl 75	750	11,000
Holmes Drlg Co	2	stm	—	Emsco ECA	1000+	15,000
Kilroy Drlg Co	3	gas	450	Brwstr N-75	1200	12,000
Miller Bros & Bowling	2	gas-btne	800	Emsco G-450	—	8,500
Neal Drlg Co	1	gas	750	Emsco G-500	560	9,500
Penrod Drlg Co	8	gas-btne	—	—	1230	10,000
Symons Drlg Co	U-15	gas	500	Unit U-15	650	9,500
W P Taylor Drlg Co	2	gas	—	Natl	900	11,000
Maverick County						
Sutton Drlg Co	1	dsl	—	—	225	3,500
	2	gas-gaso	—	—	125	2,500
McMullen County						
Allen & Morris	2	stm	400	Alco BIW 11	600	12,000/5"
	4	gas	400	Natl 50	400	8,500/5"
	8	stm	500	Emsco UBLS-54	1200	12,000/5"
Armstrong & Horn Drlg Co	1	dsl	450	Brwstr N-4	—	7,000
Buzzini Drlg Co	1	gas-btne	150	TIW	150	3,000
	8	gas-btne	1050	Wisn Titan	1210	13,000
Field Drlg Co	3	dsl	1110	Emsco 500	520	8,500
Fitzpatrick Drlg Co	2	gas	950	Unit U-40	900	10,000
J & C Drlg Co	5	dsl	800	Wisn 54	800	12,000
Longhorn Drlg Corp	4	gas-btne	450	Unit U-15	675	9,000
Medina County						
Pegg Bros Drlg Co	3	gas-btne	90	—	90	1,500/2⅜"
Midland County						
B B M Drlg Co	4	gas-btne	400	Natl 50	600	8,500/3½"
	8	gas-btne	450	Beth M-58	650	9,000/4½"
	10	gas-btne	200	Emsco GA-500	450	7,000/3½"

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Big West Drlg Co	17	gas-btne	600	Wisn Titan	900	13,000
Exploration Drlg Co	12	dsl	1200	Natl 125	1350	16,000
Foree Drlg Co	2	gas-btne	300	Unit U-15	600	7,500
Great Western Drlg Co	21	gas-gaso	—	—	1260	15,000
Helmerich & Payne Inc	9	gas	1200	"Oilwell" 96	1100	14,000
J E Jones Drlg Co	3	gas	370	Natl 50	670	7,500
Carl B King Drlg of Tex	1	gas-gaso	1000	Natl 100	1000	13,500
Llano Drlg Co	3	gas	—	"Oilwell" 96	975	14,000
	5	gas	—	Natl 100	1050	14,000
Marcum Drlg Co	6	gas-btne	900	Natl 75	1050	10,000
McQueen & Stout Drlg Co	15	LPG	225	Crdwll RL	185	4,500
Westlund Drlg Co	6	gas-btne	975	Wisn Titan	—	12,000
Zephyr Drlg Corp	3	gas	1260	Beth 950	1400	20,000/3½"
	11	gas	1260	Beth 950	1350	20,000/3½"
Mitchell County						
Dual Drlg Co	1	gas	600	Wisn Giant	600	9,000
A B See Drlg Co Inc	1	gas	400	Natl T-20	250	5,000
C D Turner Drlg Co	2	btne	180	Wisn Mogul	180	4,500
Montague County						
Jack Grace Drlg Co	5	gas-btne	500	Wisn Atlas	700	10,000
	8	gas-btne	625	Wisn Atlas	1200	10,000
Gene McCutchin	5	gas	275	Wisn Giant	275	6,500
Jerry Alex McCutchin Drlg Co	5	gas	600	Wilson	—	6,500
	8	gas	600	Wilson	—	10,000
E W Moran Drlg Co	4	gas	300	Unit U-15	650	7,500
W B Omohundro	9	btne	550	Wisn Roadair	—	6,500
Paine Drlg Co	6	btne	500	Wisn Giant	500	7,000
Revier Drlg Co	1	gas-btne	700	Unit U-15	700	8,500
Ward Drlg Co	1	dsl	350	Wisn Titan	750	6,500
Montgomery County						
Meredith & Co	4	gas-gasc-btne	—	Brwstr N-75	850	11,500
Mobile Drlg & Well Serv Co Inc	1	gas-btne	490	Ideco HD-35	450	7,000/3½"
L C Peters Drlg Contr	3	gas-btne	380	Brwstr N-45	—	8,000
Moore County						
Bolin Oil Co & D H Bolin	2	gas	225	Natl T-12	185	3,500
Cree Drlg Co Inc	7	gas-btne	185	Emsco 250	300	4,500
Wagner & Wyant Drlg Co Inc	3	dsl	175	Unit U-34	300	5,000
Nacogdoches County						
Robert M Bass Drlg Contr	1	gas-LPG	500	Wisn Roadair	800	10,000
Navarro County						
M J Delaney Co	21	gas-btne	500	Wisn Titan	650	9,500
Gibson Drlg Co	4	gas-btne	226	Wisn Mogul	225	4,500
Mustang Drlg Corp	1	dsl	—	—	360	6,500
Smith & Breyer	1	btne	146	Mayhew	135	2,500
Stroube Drlg Co	—	btne	175	Mayhew	175	1,650/2⅛"
Newton County						
Chessher Sutton & Davis Drlg	1	gas-btne	850	"Oilwell" 76	1050	10,500
	3	gas-btne	800	Unit U-15	700	9,000
Clegg & Hunt	10	btne-gas	—	Natl 50-A	—	9,500
C J Foster Drlg Co Inc	4	gas-LPG	—	Prtble CT-5	550	8,500
Prince Marine Drlg & Exp Co	3	gas	900	"Oilwell" 66	900	10,500
Carnes W Weaver Drlg Co	2	gas-btne	900	Ideco	—	11,000
Nolan County						
Brannon & Murray Drlg Co	2	gas-LPG	350	Emsco GA-350	550	6,500
M J Delaney Co	24	gas-btne	500	Beth M-58	600	9,500
Great Western Drlg Co	14	dsl	—	—	800	9,000
Roy Guffey Drlg Co	3	gas-btne	430	Unit U-34	260	5,500
	4	gas-btne	560	Unit U-15	560	7,500
	6	gas-btne	560	Unit U-15	560	7,500
Hack Drlg Co	1	btne	—	Unit U-15	412	8,500
Layton & Newell Drlg Co	1	gas-btne	500	Unit U-15	600	8,000
Marcum Drlg Co	1	gas-btne	325	Unit U-15	675	8,000
Lamar H Moore Drlg Co	1	btne	173	Crdwll RL	210	5,000
J B Schick Drlg Co	1	btne-gas	—	Crdwll 0	500	7,500
Schoenfeld-Hunter-Kitch Drlg Co	4	LPG-gas	—	Natl 75	800	11,000
Sojourner Drlg Corp	3	dsl	550	Unit U-15	—	7,500
Nueces County						
Layton Brown Drlg Co	Bge 2	dsl	—	—	800	10,000
	Bge 4	dsl	1850	"Oilwell" 96	1100	16,000
Chiles Drlg Co	1	dsl	600	Brwstr N-7	600	8,500
Dan L Clark Drlg Co	2	gas-btne	700	Emsco GC-500	—	7,500
Del Mar Drlg Co	2	dsl	—	Natl 50	—	8,000
Falco Drlg Co	1	gas	750	Brwstr N-45	400	6,500
Frio Drlg Inc	2	dsl	400	Unit U-15	400	6,500
C G Glasscock Drlg Co	14	dsl	1500	Natl 75	900	12,000
Burdette Graham	1	gas-btne	738	Beth M-58	700	9,500
Hunt Drlg Co Inc	1	gas	625	Brwstr N-7	513	9,500
Martin & Holmes Oil Well Serv Co	1	dsl-gas-gaso	770	Crdwll	370	7,000
Miller Bros & Bowling	1	gas-btne	495	Emsco G-300	—	5,500
Harold L Strader Drlg Co	Bge 401	gas-gaso-btne	—	Brwstr N-4	—	5,500
Turnbull & Zoch Drlg Co	2	stm	1600	Ideco	1000+	14,000
Ochiltree County						
Arrow Drlg Co	9	gas	560	Emsco 500	—	8,000

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Arrow Drlg Co	10	gas	560	Emsco 500	—	8,000
Baker & Taylor Drlg Co	3	dsl	800	Unit U-15	800	8,000
	4-A	gas-btne	760	Emsco G-500	750	9,500
	6	gas-btne	750	Emsco G-450	750	9,000
Cree Drlg Co Inc	9	gas-btne	350	Unit U-15	650	8,500
Empire Drlg Co	7	gas	650	Wlsn Titan	975	13,500
Falcon Seaboard Drlg Co	21	gas-btne	600	Unit U-15	600	8,500
Loffland Bros Co	77	gas	970	—	960	11,000
	98	gas	740	—	640	8,000
	146	gas	450	—	700	8,000
Lynn Drlg Co	2	gas-btne	425	Natl 75	700	10,000
Moran Bros Inc	2	gas	700	Emsco GA-500	750	10,000
Urice Drlg Co	2	gas-btne	840	Emsco GA-500	840	9,000
Webster Drlg Co	2	gas-btne	600	Emsco 450	600	8,000
Oldham County						
Beckman Inc	19	—	180	MIW P-42	175	4,000
Cree Drlg Co Inc	1	gas-btne	500	Unit U-15	750	8,500
Lynn Drlg Co	5	gas-btne	725	Natl 75	900	10,500
Wagner & Wyant Drlg Co Inc	4	gas-btne	300	Unit U-15	700	9,000
Orange County						
Admiral Drlg Co Inc	B	gas-LPG	450	Crdwll 0	362	9,500
Harry T Bryant Drlg Co Ltd	2	gas-btne	700	—	600	8,000
	3	gas-btne	700	TIW 5	600	8,000
Meadows & Walker Drlg Co	4	gas-btne	1455	"Oilwell" 76	1005	12,000
Panola County						
Tex-Mex Drlg Co	8	stm	—	—	1000+	9,000
	10	gas	—	Emsco GB-500	—	9,000
	12	gas	—	Unit U-15	—	9,000
Wise Drlg Account	1	gas	390	Unit U-15	450	7,500
	2	dsl	390	Beth MC-450	550	9,000
Pecos County						
Brantly Drlg Co Inc	5	gas	375	Emsco 250	250	4,000
Gardner Bros Drlg Co Inc	11	gas-btne	750	Natl 100	1050	12,500
	15	gas-btne	1000	"Oilwell" 96	1500	16,000
Great Western Drlg Co	9	dsl	—	—	1600	16,000
	44	dsl-elec	—	—	2000	20,000
Hissom Drlg Co	4	gas	400	Unit U-34	350	5,000
Howard C Lasiter Drlg Co	1	gas-btne	180	Brwstr N-4	340	5,000
Laughlin-Porter Drlg Co Inc	2	gas	740	Unit U-15	—	7,500
Loffland Bros Co	75	gas	970	—	960	11,000
	99	gas	870	—	960	11,000
Chas E Long Jr Inc	1	gas	200	Unit U-10	400	6,000
Parker Drlg Co	26	gas-elec	—	Natl L-10½ FE	2000	20,000
	44	gas	—	Natl L-125	1400	15,000
Penrod Drlg Co	12	gas-btne	—	—	1425	14,000
Pool & Gerlich Drlg	D-3	gas	350	Emsco G-250	300	6,000
Rowan Drlg Co Inc	28	gas-btne	1200	Natl 125	1480	15,000
Goal Tullous & Co	2	gas	600	Emsco J-750	1050	10,000
Randall County						
Riceland Corp	5	gas	800	Brwstr N-75	—	10,000
Reagan County						
Lloyd R French Co	2	gas-btne	675	Unit U-15	600	7,500
Julkirk Corp	2	gas-btne	900	Natl 75	900	11,000
Carl B King Drlg Co of Tex	10	gas-gaso	1000	Natl 75	1000	12,500
Laughlin-Porter Drlg Co Inc	7	gas	400	Wlsn Torcair	—	5,000
Pool & Gerlich Drlg	D-2	gas	260	Unit U-34	300	5,000
Rhony & Reynolds Drlg Co	4	gas	350	Natl 50	1200	7,000
Tri-Service Drlg Co	2	gas	675	"Oilwell" 66	675	8,500
	5	gas	825	"Oilwell" 76	825	10,000
Westlund Drlg Co	3	gas-btne	600	Unit U-15	—	6,500
Reeves County						
Calco Drlg Co	5	dsl	325	Beth S-45-E	300	5,500
Denver Drlg Corp	4	gas	440	Natl 50	440	8,000
Leatherwood Drlg Co	3	dsl	220	Natl T-20	—	6,000
McDaniel & Beecherl Drlg Co	6	gas-gaso	—	Hou Prtble	—	5,000
	11	gas-gaso	—	Hou Prtble	—	5,000
Western Serv Drlg Co Inc	1	gas-btne	340	Natl 50	360	5,000
	7	gas-btne	600	Natl 50	700	7,000
	10	gas-btne	1300	Beth 1013	1350	15,000
Refugio County						
Falco Drlg Co	2	gas	600	Wlsn Giant	650	8,000
Gilmour Drlg Co	2	gas	500	Natl 50	500	8,500
J & C Drlg Co	3	gas-btne	450	Natl 50	450	7,500
	6	gas-btne	450	Natl 50	450	7,500
	7	gas-btne	700	Emsco 500	600	9,000
Roberts County						
Keating Drlg Co	13	gas-gaso	—	—	1000	12,000
Reading & Bates Inc	6	gas-btne	590	Natl 75	800	9,000
Schafer Drlg Co	9	gas-gaso	300	Ideco H-35	300	7,500
Service Drlg Co	8	LPG	300	Unit U-34	—	4,500
Webster Drlg Co	9	gas-btne	—	Natl 100	1100	14,000
Robertson County						
Carnes W Weaver Drlg Co	1	gas-btne	700	"Oilwell"	—	10,500

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Runnels County						
Frank Caraway Drlg Co	1	btne-gas	225	Beth S-50	—	5,000
Cooper Drlg Co	3	gas-btne	450	Natl 50	450	6,500
Johnn Drlg Co	2	gas	375	Unit U-15	400	7,500
	5	gas	375	Unit U-15	600	8,500
Johnson-Gadbois Drlg Co	1	gas	440	Wlsn Gnt	440	8,000
J E Miller Drlg Contr	2	btne	200	Natl T-12	165	4,000
Slim Rea Drlg Co	2	dsl	275	Brwstr N-4	—	6,000
St John Drlg Co	2	gas	300	Natl 50	450	7,000
A B See Drlg Co	2	gas	400	Wlsn Mogul Torcair	250	5,000
Tex-Mex Drlg Co	9	gas	400	Emsco 250	450	5,500
Rusk County						
Carter-Jones Drlg Co	8	gas-btne	—	—	500	7,500
	12	gas-btne	—	—	720	9,000
Gibson Drlg Co	1	gas-btne	275	Wlsn Mogul 42	265	5,000
Maxwell Herring Drlg Corp	3	gas	600	Wlsn Gnt Rdair	600	9,500
Scooter's Drlg Serv	3	dsl	600	Brwstr N-55	600	6,000
J C Trahan Drlg Contr Inc	1	gas	740	Unit U-15	600	9,500
	2	gas	600	Unit U-15	600	9,500
San Jacinto County						
Bilbo-Redding Drlg Co Inc	1	dsl	750	Whind 65	550	9,500
San Patricio County						
Boyd & Durst Drlg Contr	2	gas-btne	650	Wlsn Giant	700	8,500
Del Mar Drlg Co	6	—	—	Wlsn Gnt	—	10,000
Field Drlg Co	2	dsl	1500	Unit U-15	1200	9,000
Frio Drlg Inc	3	gas-btne	800	Brwstr N-55	800	10,500
Schleicher County						
Fortune Drlg Corp	1	gas	325	Beth S-55C	524	7,500
Tucker Drlg Co	5	gas	620	Crdwll 0	620	9,500
Scurry County						
Calco Drlg Co	1	gas-btne	225	Mayhew 3000	200	3,500
Dearing Inc	4	gas-btne	—	Wlsn	—	4,000
Duval Drlg Co	5	gas	400	Emsco GA-500	400	7,000
Irish Drlg Co Inc	2	btne	280	Wichtex R-3	—	3,000
Johnn Drlg Co	9	gas	375	Brwstr N-45	400	7,000
King-Phillips Inc	3	dsl	622	Ideco H-40D	—	5,500/4"
Chas E Long Jr Inc	2	dsl	250	Emsco GA-500	520	10,000/3½"
McQueen & Stout Drlg Co	12	LPG	225	Crdwll RL	185	4,500
Rhodes & Hicks Drlg Corp	2	btne	370	Natl T-32	370	6,500
	3	btne	370	Crdwll S	185	4,500
Shackelford County						
Black Drlg Co	1	dsl	275	Franks	250	4,000/3½"
Dearing Inc	3	gas-btne	—	Wichtex	—	3,000
Gore Drlg Co	1	dsl	640	Shovel Spl	—	7,500
	3	gas	254	Joy 200-A	—	2,500/2¼"
Sherman County						
Cree Drlg Co Inc	3	gas-btne	225	Wlsn Giant	300	5,000
	8	gas-btne	185	Unit U-34	300	4,500
Smith County						
B G Byars Power Drlg Co	1	gas-btne	1170	Beth MC-450	775	11,000
	2	gas-btne	1145	Emsco GA-500	750	10,500
South States Drlg Co	3	dsl	330	Emsco GB-350	520	8,000/4"
Starr County						
Clark Fuel Prod Co	2	dsl	740	Wlsn Gnt	520	8,500
Turnbull & Zoch Drlg Co	3	gas-btne	1125	Wlsn Titan	1125	16,000
	5	gas-btne	850	Unit U-15	850	9,500
Stephens County						
American Drlg Corp	1	gas-btne	450	Emsco 500	450	6,000
	2	gas-btne	450	Emsco 750	450	7,500
Dixon Drlg Co	1	dsl-gas	260	Natl T-20	260	5,000
Ewing Drlg Co	1	btne	—	Emsco C-42	450	5,000
Irish Drlg Co Inc	4	btne	360	Wichtex R-5	—	4,000
A F Knappenberger & K & H Drlg Co	1	gas	350	Emsco GA-500	500	7,000
Oney Drlg Co	5	gas	250	Crdwll S	200	4,000
Red River Drlg Co	2	gas	165	Wichtex R-4	140	3,500/3½"
Stephens Oil & Gas Corp	1	gas	225	Unit U-34	165	4,500
Taylor Expl Co Inc	3	gaso	—	Mayhew	75	1,000
	5	gaso	—	Mayhew	75	1,000
Tommy Ward Drlg Co	2	gas	300	Beth 350	426	7,000
Wright Clark & Senkel Inc	11	gas-btne	450	Wlsn Giant	450	7,500
Sterling County						
Empire Drlg Co	8	gas	500	Unit U-15	650	8,500
Stonewall County						
J & L Drlg Co Ltd	1	dsl	—	Brwstr N-55	500	7,200
Kuehn & Roberts Drlg Contrs	1	pwr	300	Wlsn Giant	480	7,500
Lamar H Moore Drlg Co	3	btne	250	Unit U-15	552	8,000
W B Omohundro	8	btne	700	Wlsn Roadair	—	8,000
J B Schick Drlg Co	2	btne-gas	—	Crdwll 0	450	7,000
Wes-Tex Drlg Co	6	btne	675	Unit U-15	675	9,500
West Central Drlg Co	8	gaso-btne	325	Wlsn Roadair	975	10,000
Sutton County						
Tucker Drlg Co	4	dsl	610	Beth J-55	—	9,500

Here's why the O·C·T "JE" is the *Largest Selling Flow Control*



Body can accommodate any size positive choke to 1" or adjustable choke up to ¾" opening.

Hard faced 1" valve seat is replaceable to permit complete renewal of valve in five minutes.

True valve-type gate is hard-faced for long life under severe conditions.

Ball thrust bearing assures easy operation under highest pressures.

Producers have made the O-C-T Type "JE" the largest selling flow control because it helps them reduce both first cost and maintenance expense. It is the only flow control on the market that gives you the advantage of both a choke and a true valve-type gate assembly and seating arrangement.

The O-C-T type "JE" Flow Control is available through any Christmas tree manufacturer or through more than 700 supply store locations.

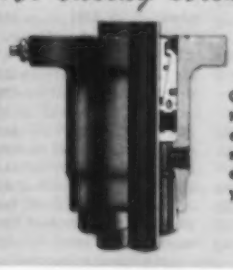
O·C·T

OIL CENTER TOOL CO.

A SUBSIDIARY OF FOOD MACHINERY AND CHEMICAL CORPORATION

Export Representatives: South America — East West Oiltools, C. A., Del Lago Hotel, Maracaibo, Venezuela. Address Export Inquiries for All Other Countries to P. O. Box 3091, Houston, Texas.

No casing string too long . . .



The O-C-T C-19 Casing head can support the longest strings with complete safety. It is the safest, most economical deep well casing head you can buy.

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Taylor County						
Andree Drlg Co	1	dsl	310	Unit U-34	310	4,500
Dixon Drlg Co	3	gas	500	Natl 50	520	7,500
Hack Drlg Co	2	btne	—	Crdwll S	161	4,500
Moore & Moore Drlg Co	4	btne	175	Unit U-34	210	5,000
Norman Oil Corp	2	dsl	330	Unit U-10	350	5,000
Paine Drlg Co	5	btne	450	Wlsn Giant	450	7,000
St John Drlg Co	1	gas	400	Wlsn Gnt Rd	700	8,500
Thomas & Billups Drlg Co	2	btne	450	Emsco 300	450	6,000
Wes-Tex Drlg Co	2	btne	244	Brwstr N-4	280	5,500
West Central Drlg Co	9	gaso-btne	225	Crdwll H	250	3,000
Woodson Prod Co	2	gas	600	Unit U-15	900	8,500
	3	gas	300	Mayhew 3000	200	4,000
	4	dsl	600	Mayhew 5000	270	5,500/4"
Terrell County						
Great Western Drlg Co	11	dsl	—	—	500	9,000
Terry County						
Empire Drlg Co	5	gas	395	Unit U-15	570	8,000
Hissom Drlg Co	6	gas	1000	Emsco A-800	1000	11,000
Livermore Drlg Co	1	gas	870	Wlsn Titan	975	12,500
Milhoan Drlg Co	6	gas	600	Unit U-15	—	8,000
Throckmorton County						
Alan Drlg Co	1	gas	550	Wlsn Giant	850	8,000
Edwards Drlg Co	3	gas-gaso	600	Unit U-15	600	9,000
Hale Bros Drlg Co	1	dsl	—	Whind	—	8,000
Karper & Glass	2	gas	425	Beth C-50	425	6,000
Dwight M Ross Drlg Co	1	gas-btne	300	Wlsn Atlas	660	7,500
Schulz & Brannan Drlg Co	1	dsl	400	Wlsn Mogul	400	5,000
Sheets & Walton Drlg Co	3	pwr	365	Brwstr N-4	285	5,000
Titus County						
W B Hinton	1	stm	750	Alco BIW-11	—	10,000
	2	dsl	—	Unit U-15	350	12,000
Tom Green County						
Brannon & Murray Drlg Co	1	gas-LPG	550	Brwstr N-55	550	7,500
Dykes Drlg Co	2	dsl	400	Wlsn Gnt	600	8,000
	3	gas	400	Natl 50	650	8,000
Great Western Drlg Co	5	gas-gaso	—	—	750	7,500
Tucker Drlg Co	1	gas	600	Brwstr N-55	—	9,500
Trinity County						
Delta Drlg Co	17	gas-btne	1020	Emsco J-1100	1300	15,000
Upton County						
Harry Bass Drlg Co	111	gas	1200	Emsco	1200	14,000
Cooper Drlg Co	5	gas-btne	600	Wlsn Giant	600	7,500
Empire Drlg Co	3	gas	500	Brwstr N-7	975	11,000
Foree Drlg Co	4	gas-btne	325	Emsco GA-500	500	7,500
Fortune Drlg Corp	2	gas	300	Unit U-15	590	7,500
Fryer & Hanson Drlg Co	11	gas-btne	1200	Beth M-58	1200	12,000
Gardner Bros Drlg Co Inc	10	gas-btne	750	Natl 100	1050	12,500
Helmerich & Payne Inc	37	gas	1200	"Oilwell" 96	1450	15,000
J E Jones Drlg Co	2	gas	500	Unit U-15	663	7,500
Julkirk Corp	1	gas-btne	600	Natl 50	600	8,000
La Mance Drlg Co	4	btne	1050	Wlsn Titan	—	13,000
Laughlin-Porter Drlg Co Inc	4	gas	1650	Ideco 1350	—	14,000
Llano Drlg Co	4	gas	—	Natl 75	700	12,000
Lomax Drlg Co	1	gas-btne	300	Unit U-15	650	8,500
	2	gas-btne	300	Unit U-15	650	8,500
Lowe Drlg Co	3	gas	1000	Natl 100	—	12,500
Norwood Drlg Co	7	gas-gaso	650	Wlsn	600	9,500
Penrod Drlg Co	32	dsl	—	—	1460	15,000
Fred Pool Drlg Co	1	gas	580	Unit U-15	600	7,500
Rheay & Reynolds Drlg Co	3	gas	400	Unit U-15	1200	6,500
	5	gas	350	Natl 75	1200	7,000
Schoenfeld-Hunter-Kitch Drlg Co	1	LPG-gas	—	Beth 650	1000	14,000
Sharp Drlg Co	37	gas	900	Beth MC-450	900	12,000
Triad Drlg Co	5	gas-btne	650	Beth 450	650	12,000
Tri-Service Drlg Co	7	gas	370	Natl T-20	370	5,800
Western Drlg Co Inc	13	dsl	600	Crdwll 0	325	9,000
	14	dsl	375	Emsco 500	375	8,000
Westlund Drlg Co	7	gas-btne	650	Wlsn Roadair	—	7,500
Val Verde County						
Hewgley Drlg Co	2	gas-btne	—	Ideco	1400	14,000
Victoria County						
Appell Drlg Co	4	gas-gaso	315	Wlsn Mogul	175	8,000
Harkins & Co	3	gas-gaso	675	Unit U-15	675	10,000
Holmes Drlg Co	6	gas-gaso	—	Beth MC-450	700	10,000
Ward County						
Dixilyn Drlg Corp	3	gas	950	Natl 100	950	14,000
Lloyd R French Co	1	gas-btne	300	Unit U-10	300	4,500
Gardner Bros Drlg Co Inc	20	gas-btne	275	Natl T-25	350	4,000
Hissom Drlg Co	3	gas	450	Beth S-60	450	6,500
Loffland Bros Co	123	gas	1350	—	1350	14,000
Ormand Bros Drlg Co	2	gas	550	Wlsn Giant	550	7,000
Red River Drlg Co	1	dsl	200	Wichtex R-4	165	3,000
Western Serv Drlg Co Inc	8	gas-btne	600	Beth MC-650	700	11,000
	12	dsl	250	Natl T-20	520	4,000
Webb County						
Dillard-Waltermire Inc	2	dsl	1800	Natl 125	2400	16,000
Wharton County						
Admiral Drlg Co Inc	A	gas-gaso-btne	250	"Oilwell" 64-A	300	7,000
CBS Workover Co	1	gas-btne	300	Ideco H-30D	215	4,500
Wichita County						
Jim Fish Drlg Co	1	gas	165	Wilson	140	4,000
Gray Drlg Co	1	gas-gaso	220	Wlsn Gnt Roadair	450	5,500
Hale Bros Drlg Co	3	gas	—	Unit U-34		4,500
B M Hester	1	btne	325	Natl T-20	200	6,000
Hull Oil Co	1	btne	140	Wlkr-Nr R-2	—	2,000
S D Johnson	11	dsl	175	Unit U-34	300	5,000
Meredith Drlg Co	2	btne	500	Wlsn Giant	225	7,500
W B Omohundro	10	btne	300	Brwstr N-3	—	4,500/3½"
Harold Shappell Drlg Co	1	gas	245	Wichtex	145	2,800
Jack L Story	5	gas-btne	450	Wlsn Giant	450	7,500
Wilbarger County						
Bolin Oil Co & D H Bolin	4	gas	350	Wlsn Gnt	500	7,500
Jennings Drlg Co	4	btne-gas	450	Unit U-15	600	8,000
Lofton Oil Co	1	btne	300	Beth Breeze	—	5,500
Willacy County						
Allen & Morris	7	dsl	500	Natl 75	900	10,000/5"
Wilson County						
Pegg Bros Drlg Co	2	gas-btne	110	—	110	3,000/3½"
Sutton Drlg Co	5	gas-gaso	—	Wlsn	125	1,500
Winkler County						
Arrow Drlg Co	23	gas	840	Wilson	—	10,000
Robert M Bass Drlg Contr	2	gas-LPG	350	Brwstr N-45	350	7,000
Bolin Oil Co & D H Bolin	7	gas	225	Beth S-50	185	4,500
Brantly Drlg Co Inc	8	gas	675	Beth 450	870	11,500
Calco Drlg Co	4	gas-btne	215	Beth Breeze	280	5,500
Choya Drlg Co Inc	4	gas-btne	1400	Emsco J-1400	1400	15,000
Coroco Drlg Co	4	gas-gaso	650	Wlsn Spr Titan	900	15,000
Danforth Drlg Co	1	dsl	240	Ideco H-30	350	5,000
Dillard-Waltermire Inc	13	gas	800	Wlsn Titan	1200	12,000
Eastland Drlg Co	1	gas	—	—	750	10,000
Frank Frawley Drlg Co	2	gas	—	Unit U-20	1050	13,000
Gardner Bros Drlg Co Inc	12	gas-btne	750	Natl 100	1050	12,500
Great Western Drlg Co	16	gas-gaso	—	—	1260	15,000
Keating Drlg Co	8	gas-gaso	—	—	650	8,500
King-Phillips Inc	1	gas-gaso	695	Natl 50	—	7,500
Layton & Newell Drlg Co	7	stm	500	Natl 34-26-9	1000+	15,000
Loffland Bros Co	80	gas	1000	—	960	11,000
	89	gas	970	—	1050	11,000
O'Neal Drlg Co	1	gas-gaso	—	Beth S-45-E	200	5,500
	2	gas-gaso	—	Beth S-45-E	200	5,500
Fred Pool Drlg Co	3	gas	225	Brwstr N-3	250	4,000
Sharp Drlg Co	35	gas	1200	Beth M-810	1200	12,000
A W Thompson Inc	4	gas	650	Beth 810	1050	13,500
	8	gas	450	Beth 58	750	10,000
	10	gas	600	Clark Pr-1000	1050	13,500
	12	gas	350	Emsco 350	600	7,000
Urice Drlg Co	3	gas-btne	700	Emsco GB-500	700	9,000
Western Serv Drlg Co Inc	13	gas-btne	550	Beth S-45-E	350	5,000
Wise County						
Bolin Oil Co & D H Bolin	6	gas	350	Wlsn Gnt Rdair	250	6,500
Carter-Jones Drlg Co	6	gas-btne	—	—	350	6,800
	7	gas-btne	—	—	300	6,500
	11	gas-btne	—	—	280	6,500
Jack Grace Drlg Co	20	gas-btne	370	Wlsn Giant	700	8,000
Hamman Oil & Ref Co	7	dsl	340	Brwstr N-75	600	11,000
John W Harris Drlg Co	1	gas	500	Hou Prtble	450	6,500
	2	gas	500	Emsco GC-500	500	8,000
Johnson-Gadbois Drlg Co	5	gas	410	Wlsn Mogul	—	4,000
Karper & Glass	3	dsl	450	Beth S-55	450	7,000
	5	dsl	276	Beth S-45	276	5,500
Leatherwood Drlg Co	4	gas	450	Crdwll	450	6,000
McCutchen & Graham	1	btne	425	Wlsn Spr Atlas	650	11,000
	2	btne	255	Unit U-15	570	7,500
	3	btne	350	Wlsn Spr Gnt	650	9,000
Pan-Tex Drlg Co	1	gas	350	Brwstr N-45	400	6,500
T & O Drlg Co	1	gas-btne	240	Unit U-34	230	5,000
Trio Drlg Co	1	dsl-gas	520	Wlsn Giant	—	8,000
	2	dsl-gas	520	Crdwll O	—	8,500
	3	gas	450	Wlsn Giant	—	6,500
	4	gas	450	Natl 50	—	6,500
Walters Drlg Co Inc	12	dsl	—	Mayhew 1000	300	400/2⅞"
Wood County						
Robert M Bass Drlg Contr	5	gas-LPG	300	Wlsn Giant	300	5,500
M J Delaney Co	25	stm	—	Emsco UBLS 54	—	15,000
Delta Drlg Co	7	stm	750	Emsco UB -54	1200	12,000

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Delta Drlg Co	22	gas-btne	530	Unit U-15	600	8,000
Gibson Drlg Co	2	gas-btne	226	Wlsn Mogul 42	145	5,000
	5	gas-btne	275	Wlsn Giant	275	6,000
Halbert Drlg Co	1	gas-btne	255	Wlsn Torcair	285	5,500
South States Drlg Co	1	dsl	330	Crdwll O	520	6,500
Yoakum County						
Drlg & Expl Co of Del Inc	14	gas-elec	1100	Natl 34-10	1000	17,000
Empire Drlg Co	10	gas	400	Brwstr N-4	300	5,500
Frisbie Drlg Co	2	btne	675	Brwstr N-7	675	9,000-4"
Gardner Bros Drlg Co Inc	14	gas-btne	750	Natl 100	1050	12,500
Great Western Drlg Co	4	gas	—	—	800	9,000
Sharp Drlg Co	18	gas	1350	Beth MC-950	1350	15,000
Tucker Drlg Co	3	gas	600	Ideco TC-600	—	9,500
Western Drlg Co Inc	15	dsl	375	Emsco 500	375	8,000
	16	dsl	600	Emsco 350	290	6,000
Western Serv Drlg Co Inc	11	gas-btne	1000	Beth 810	1100	11,000
Young County						
Bolin Oil Co & D H Bolin	10	dsl	300	Wlsn Giant	300	4,500
E & H Drlg Co	1	gas	550	Unit U-15	550	7,500
Edwards Drlg Co	2	gas-gaso	600	Unit U-15	600	9,000
Hamilton-Powell Drlg Co Inc	1	gas	225	Wlsn Mogul	—	4,500
J W Hastings Drlg Co	4	gas-btne	330	Wlsn Torcair	220	5,000
	5	gas-btne	864	Wlsn Gnt Rdair	864	8,200
Karper & Glass	6	gas	276	Wilson	212	3,500
Keoughan Drlg Co Inc	1	dsl	520	Crdwll O	—	8,500
A F Knappenberger & K & H Drlg Co	2	gas	200	Wlsn Mogul	400	5,000
Louis Pitcock Drlg Co	1	gas-btne	225	Beth S-55	600	7,500
	2	gas-btne	225	Beth S-45	3250	4,000
Revier Drlg Co	4	gas-btne	213	Brwstr N-3	145	3,500
Stephens Oil & Gas Corp	1	gas	225	Unit U-34	183	4,500
Turner & West	1	gas	300	Natl T-32	300	5,500
Varner-Neill Drlg Co	1	gas	500	Wlsn Giant	450	6,000
		UTAH				
Duchesne County						
Pioneer Drlg Co Inc	5	dsl	850	Emsco J-750	1000	12,000
Emery County						
Moran Bros Inc	7	gas	700	Wlsn Giant	750	10,000
Mountain States Drlg Co Inc	11	gas-dsl	1000	Natl 80-B	—	12,500
	3	dsl	800	Emsco GA-500	700	9,000
Grand County						
Camay Drlg Co Rocky Mt Div	6	dsl	260	Johnson	450	5,000
San Juan County						
Anschutz Drlg Co Inc	4	gas	800	Wlsn Giant	600	8,500
Arapahoe Drlg Co	2	gas-btne	300	Natl T-32	320	6,000
	4	gas-btne	375	Natl 50-A	680	8,000
Basin Drlg Corp	1	gas	600	Unit U-15	600	8,000
	2	gas	600	Unit U-15	600	8,000
Calvert Drlg Inc	20	dsl	350	Ideco H-525	600	8,500
Camay Drlg Co Rocky Mt Div	5	gas	680	Natl 50-A	450	7,500
Carmack Drlg Co	4	dsl	472	Natl T-32	320	6,000
	7	dsl	300	Natl T-12	300	4,000
D-K Drlg Co	1	gas	675	Natl 50	675	7,500
	3	gas	500	Natl 50	500	6,500
Exeter Drlg Co	3	btne	630	Natl 50-A	630	8,500
Exploration Drlg Co	1	gas	310	Beth S-60	250	6,000
	4	gas	625	Unit U-15	600	8,000
	8	gas	670	Unit U-15	600	8,000
	15	gas	800	Natl 75-CA	900	11,000
	16	gas	625	Natl 75	600	9,000
Great Western Drlg Co	20	dsl	—	—	600	5,500
	30	gas-gaso	—	—	750	7,500
	36	gas-gaso	—	—	675	7,500
	42	dsl	—	—	800	9,000
Hewit-Gulick Drlg Co	3	gas-btne	600	Natl 50-CA	900	8,000
Kerr-McGee Oil Ind Inc	1	gas	825	Unit U-15	832	10,000
Loffland Bros Co	139	gas	720	—	900	9,000
R L Manning Co	4	gas-btne	600	Emsco 450	450	7,000
	12	gas-btne	550	Emsco GA-350	450	7,000
	16	gas-btne	475	Natl T-32	450	6,000
Moran Bros Inc	8	gas	700	Wlsn Giant	750	10,000
	3	gas	700	Emsco GB-350-52	750	8,500
Mountain States Drlg Co Inc	6	dsl	600	Natl 50	—	7,500
George Noland Drlg Co Inc	9	gas-btne	—	Emsco G-500	730	8,500
Nye & Snell Drlg Co	1	gas	375	"Oilwell" 66	550	6,000
R W Rine Drlg Co	2	dsl	520	Brwstr N-7	600	8,500
	6	dsl	520	Brwstr N-75	750	12,000
Sevier County						
Mountain States Drlg Co Inc	15	gas-dsl	1400	Natl 125	—	15,000
Summit County						
A O Bullock Drlg Co	2	gas	225	Crdwll S	—	4,000
Uintah County						
Dellson Drlg Co	3	gas-btne	520	Emsco GB-500	520	7,500
Kerr-McGee Oil Ind Inc	4	gas	900	Natl 75	832	11,500
	23	gas	650	Natl 50	555	9,000
	42	gas	970	Natl 75	818	11,500
Mountain States Drlg Co Inc	3	gas-dsl	600	Natl 50-A		7,500
	4	gas-dsl	600	Emsco GB-500		9,000
Utah County						
Mountain States Drlg Co Inc	2	gas-dsl	1000	Emsco J-750		10,000
		VIRGINIA				
Buchanan County						
Eakle & Holder Drlg Co	3	dsl	300	Ideco H-30		5,500
		WEST VIRGINIA				
Jackson County						
Delta Drlg Co	27	dsl	380	Emsco GA-350	350	6,000
Randolph County						
S W Jack Drlg Co	2	dsl	800	Unit U-15	800	8,500
Roane County						
Eakle & Holder Drlg Co	5	dsl	600	Natl 50	600	8,500
Tyler County						
Delta Drlg Co	29	dsl	750	Emsco J-750	750	12,000
		WYOMING				
Big Horn County						
Dellson Drlg Co	2	gas-btne	430	Emsco GA-250	335	6,000
Delta Drlg Co	17	dsl	630	Natl 75	650	9,500
True Drlg Co	9	gas-gaso	1200	Unit U-40	1200	11,000
Campbell County						
Anschutz Drlg Co Inc	9	gas	800	Natl 50-A	600	8,500
	11	gas	1000	Wlsn Giant	700	8,500
Falcon Seaboard Drlg Co	9	gas-btne	325	Unit U-15	—	8,500
Hewit-Gulick Drlg Co	1	dsl	970	Natl 50-A	600	8,000
A L Schlaikjer	1	gas	700	Wlsn Gnt Rdair		8,000
True Drlg Co	10	gas-LPG	675	Unit U-15	675	8,500
Carbon County						
Carpenter-Trant Drlg Co	1	btne	185	Crdwll RL	185	3,000
Delta Drlg Co	23	dsl	520	Emsco GA-500	500	8,000
Pioneer Drlg Co Inc	4	dsl	750	Emsco GB-500	600	9,000
Converse County						
Black Hills Drlg Co Inc	2	dsl	1000	Emsco GA-500	—	12,000
Bueno Drlg Co	1	dsl	700	Natl T-20	270	5,000
True Drlg Co	5	elec	400	Emsco H-46	400	9,000
Crook County						
True Drlg Co	6	gas-gaso	500	Beth Twstr	600	8,500
	8	gas-gaso	500	Natl 50	500	7,500
Fremont County						
Brack Drlg Co Inc (Colo)	4	dsl	—	—	254	5,500
Carpenter-Trant Drlg Co	6	dsl	450	Wlsn Giant	640	7,500
Dyer Drlg Co	3	dsl	185	Failing 66	300	3,500
Kerr-McGee Oil Ind Inc	28	gas	770	Natl 75	832	11,500
Loffland Bros Co	27	gas	970	—	1100	11,000
R L Manning Co	11	gas-btne	1080	Emsco J-1000	1305	13,000
	15	dsl	540	Emsco GB-250	340	6,000
George Noland Drlg Co Inc	7	gas-btne	—	Emsco PDM-36	440	5,000
	10	gas-btne	—	Emsco PDM-36	440	5,500
Taylor Expl Co Inc	1	btne	—	Mayhew	125	3,000
	7	btne	—	Mayhew	—	1,200
Hot Springs County						
Dyer Drlg Co	1	gas-gaso	325	Natl T-32	365	6,000
R L Manning Co	7	gas-btne	750	Emsco G-500	750	8,000
J D Sprecher	5	dsl	350	Brwstr N-45	350	6,500
Johnson County						
Anschutz Drlg Co Inc	8	gas	900	Unit U-15	600	8,500
Loffland Bros Co	100	gas	670	—	675	8,000
Olds & Wrather Drlg Co	3	dsl	900	Natl 50	900	7,500
Signal Expl Inc	1	dsl	500	Unit U-15	625	8,000
Laramie County						
S D Johnson	3	gas	500	Wlsn Titan 6472	900	14,000
Lincoln County						
Kerr-McGee Oil Ind Inc	31	gas	1000	Natl 100	1680	15,000
Natrona County						
Big Horn Drlg Co Inc	1	dsl	220	Emsco 250	—	4,500
	3	dsl	600	Brwstr N-4	—	7,500
Don Johnston Drlg Co	5	gas-btne	775	Natl 75	775	10,000
Loffland Bros Co	7	dsl	970	—	960	11,000
	137	dsl	1000	—	1200	14,000
R L Manning Co	2	gas-btne	600	Emsco 300	300	5,500
Morrison Drlg Co Inc (Wyo)	8	dsl	210	Frnks Comet	225	5,000
George Noland Drlg Co Inc	11	gas-btne	—	Unit U-15	730	8,500
True Drlg Co	7	dsl	185	Failing	165	3,500
Niobrara County						
A O Bullock Drlg Co	1	gas	225	Wichtex R5	—	3,500
George Noland Drlg Co Inc	6	gas-btne	—	Wlsn Mogul	440	4,000
Bob Olds Drlg Co	2	gas	235	Wlsn Mogul	350	6,000
Park County						
Mountain States Drlg Co Inc	9	gas-dsl	1400	Natl 125	—	15,000

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Sheridan County						
Delta Drlg Co	28	dsl	350	Frnks SAL-6000	600	5,000
Sublette County						
Camay Drlg Co Rocky Mt Div	3	dsl	510	Natl 50-A	450	7,500
Kent Drlg Co	2	dsl-gas	—	Natl 50	750	7,500
R L Manning Co	5	gas-btne	750	Emsco G-500	750	8,000
Sweetwater County						
Camay Drlg Co Rocky Mt Div	1	gas	730	Unit U-15	600	8,000
R L Manning Co	9	dsl	550	Natl 50	550	7,500
Reserve Drlg Co Inc (Casper)	3	gas-LPG	500	Natl 50	500	7,500
Washakie County						
Anschutz Drlg Co Inc	7	gas	900	Unit U-15	600	8,500
Carpenter-Trant Drlg Co	5	dsl	900	Brwstr	900	12,000
Clark Drlg Co	—	dsl	—	Natl 50	525	6,500
Dellson Drlg Co	1	gas-btne	740	Emsco GB-500	740	8,500
R L Manning Co	6	gas-btne	900	Emsco GB-800	1125	11,000
	10	gas-btne	1275	Emsco J-750	1125	11,000
Mountain States Drlg Co Inc	14	dsl	800	Ideco M-1000	—	10,000
Weston County						
Olds & Wrather Drlg Co	1	gas	675	Emsco GB	675	7,000
Bob Olds Drlg Co	4	dsl	240	Crdwll RL	180	4,000
True Drlg Co	4	gas-gaso	400	Emsco GA-250	250	6,000

U. S. Contract CABLE TOOL Drilling Rigs

Contractor's Name	Rig No.	Type Power	HP of Driving Engine	Top to Bottom Drlg Cap.	Workover and Cleanout Depth Cap.	Rig Make and Model
ALABAMA						
Marion County						
Harry L Cullet	—	gas-gaso-btne	250	7000	7500	Special
	—	gas-gaso-btne	125	3000	3500	Crdwll H
Talladega County						
Harry L Cullet	—	gas-gaso-btne	150	5000	5500	Star Spdr
ARKANSAS						
Franklin County						
W C Holt Drlg Co	1	gas	140	3500	4000	Wlkr-Nr
CALIFORNIA						
Kern County						
B & B Drilling Co	1	gas	145	3500	—	B Erie 36-L
	3	btne	—	—	—	—
Ventura County						
United Drlg Co	2	gas	75	2000	—	Keystone A-50
COLORADO						
Larimer County						
Signal Oilfield Serv	5	dsl	200	—	8000	Crdwll RL
Rio Blanco County						
R & R Well Serv Co	—	dsl	200	7000	8000	Crdwll RL
Routt County						
Western Drlg Co Inc	5	btne	185	—	—	B Erie 48-L
	10	btne	185	—	—	B Erie 48-L
Weld County						
Signal Oilfield Serv	4	dsl	200	—	8000	Crdwll RL
ILLINOIS						
Christian County						
V S & S Drlg Co	1	gas	—	—	2000	Wichtex
Clark County						
Donald P Knierim	1	gas	65	1500	2000	B Erie 60-L
Clay County						
Shulman Bros	1	gas-gaso	—	4000	—	Crdwll H
	2	gas-gaso	—	4000	—	Crdwll H
Don Slape Drilling Co	1	btne	—	—	—	Crdwll K
Crwaford County						
Payne Bros Drlg Co	2	dsl	150	3000	4000	B Erie 36-L
Douglas County						
C W Strotman Drilling Co	1	gas	145	3600	4500	Crdwll H
	2	gas	145	3600	4500	Crdwll H
	3	gas	130	3000	3500	Crdwll K
Gallatin County						
V S & S Drlg Co	3	gas	—	3500	3500	Cooper
Jefferson County						
Graham Powell	1	btne	500	4200	4200	B Erie 36-L
Lawrence County						
W L Dillier	2	gas	65	1500	2000	B Erie 60-L
Payne Bros Drlg Co	1	dsl	150	3000	4000	B Erie 36-L
Pike County						
W L Dillier	1	gas	65	1500	2000	B Erie 60-L
Saline County						
C E Brehn	4	btne	184	—	5000	Crdwll K
	8	btne	184	—	5000	Crdwll K
Wabash County						
Payne Bros Drlg Co	3	dsl	150	3000	4000	B Erie 36-L
INDIANA						
Gibson County						
Highland Oil	1	dsl	—	2000	—	B Erie 24-L
	2	dsl	—	3000	—	B Erie 28-L
Princeton Mining Co	1	gas	85	—	3500	Crdwll L
South State Drlg	2	dsl	110	—	10,000	Crdwll R
	3	dsl	110	—	4200	Cooper
C W Strotman Drlg Co	4	gas	175	3500	4000	B Erie 36-L
Posey County						
Houchins Drlg Co	2	gaso	150	5000	—	Frnks Spdr
IOWA						
Dallas County						
Kirby Oil Ind	—	gas-gaso	—	—	—	B Erie 28-L
KANSAS						
Barber County						
Mobile Drlg Co	2	gas	100	—	5000	Crdwll
	5	gas	100	—	5500	Crdwll
Patton Drlg Co Inc	3	gas	—	—	—	Crdwll
Butler County						
Rex & Morris Drlg Co	1	dsl	—	3500	4500	B Erie 36-L
Strait Drlg Inc	1	gas	175	3500	4000	B Erie 36-L
J H Wagner Drlg Co	3	gas-LPG	145	3500	4500	B Erie 36-L
Cowley County						
Carter Drlg Co	1	LPG	145	3500	6500	Wlkr-Nr S-43
	3	LPG	160	2000	4500	Wisn Mogul
Paul Septer Drlg Co	7	btne	—	4500	—	B Erie 36-L
SeRoBee Drlg Co Inc	1	btne	—	4000	—	Crdwll RL
	2	btne	—	4000	—	Crdwll RL
L C Smitherman Drlg Co	6	btne	—	7500	—	Crdwll RL
J H Wagner Drlg Co	2	gas-LPG	145	3500	4500	B Erie 36-L
Elk County						
R L Horn & Sons Drlg Co	1	dsl	60	1600	2000	Star 72
Ellis County						
Signal Oilfield Serv	3	gas	145	—	6000	Crdwll RL
	7	gas	145	—	5000	Wlkr-Nr C-34
Graham County						
Signal Oilfield Serv	9	dsl	150	—	6000	Crdwll RL
Meade County						
Graham-Michaelis Drlg Co	2	dsl	175	3000	8000	Crdwll
Montgomery County						
Veeder Supply & Dev Co	BE2	dsl	120	3500	4500	B Erie
Morton County						
Graham-Michaelis Drlg Co	1	dsl	175	3000	8000	Crdwll
Osage County						
Signal Oilfield Serv	8	gas	145	—	5000	Wlkr-Nr C-34
Pratt County						
Signal Oilfield Serv	1	dsl	200	—	6000	Crdwll RL
Rooks County						
Mobile Drlg Co	4	gas	100	—	5500	Crdwll
Russell County						
Shields Oil Producers	2	gas	145	3500	3500	B Erie 48-L
Sedgwick County						
Carter Drlg Co	2	LPG	145	2000	4500	Wlkr-Nr C-33
Mobile Drlg Co	1	gas	75	—	3600	Crdwll
	3	gas	100	—	5500	Crdwll
Seward County						
Graham-Michaelis Drlg Co	3	dsl	150	3500	6000	B Erie 36
Stafford County						
Signal Oilfield Serv	6	dsl	200	—	6000	Crdwll RL
KENTUCKY						
Muhlenberg County						
Perrine & Perrine Drlg Contr	2	btne	145	—	6000	B Erie 36-L

Contractor's Name	Rig No.	Type Power	HP of Driving Engine	Top to Bottom Drlg Cap.	Workover and Cleanout Depth Cap.	Rig Make and Model
LOUISIANA						
De Soto County						
Dudley C Beene Inc	3	gas	145	5000	10,000	Wisn Mogul
MICHIGAN						
Allegan County						
Muskegon Development Co	—	dsl	150	5000	5000	Natl
Bay County						
Muskegon Development Co	—	dsl	150	5000	5000	Natl
Clare County						
Union Rotary Corp	3	gas-gaso-LPG	150	7500	10,000	Crdwll RL
Gladwin County						
Muskegon Development Co	—	dsl	150	5000	5000	Natl
	—	dsl	150	5000	5000	Natl
Union Rotary Corp	1	gas-gaso-LPG	120	5000	7000	Crdwll KL
Mason County						
Union Rotary Corp	5	gas-gaso-LPG	150	7500	10,000	Crdwll RL
Midland County						
Union Rotary Corp	6	gas-gaso-LPG	180	7500	10,000	Crdwll RL
Montcalm County						
McClure Oil Co	1	gas	145	5000	5000	B Erie 36-L
	2	gas	145	5000	5000	B Erie 36-L
	3	gas	145	5000	5000	B Erie 36-L
	4	gas	145	4500	4500	B Erie 36-L
	5	gas	145	4500	4500	B Erie 36-L
Oceana County						
Bernhardt Drlg Co	1	gas-btne	78	3000	—	B Erie 28
Osceola County						
Gordon Drlg Co	5	gas-LPG	150	4000	5000	Crdwll H
Union Rotary Corp	2	gas-gaso-LPG	120	5000	7000	Crdwll KL
Saginaw County						
Muskegon Development Co	—	LPG	165	6000	6000	Wlkr-Nr S-33
Union Rotary Corp	4	gas-gaso-LPG	150	7500	10,000	Crdwll RL
MONTANA						
Fallon County						
Signal Oilfield Serv	10	dsl	225	—	12,000	Frnks Clpr
Glacier County						
M-H-O Drlg Co	4	gas-btne	165	3500	5000	B Erie 36-L
	6	dsl	140	3000	4500	B Erie 36-L
	7	dsl	220	6000	8000	B Erie 48-L
Liberty County						
B & B Drlg Co (Montana)	1	gas	145	3500	—	B Erie 36-L
Pondera County						
J W Lawrence	1	gas-gaso	125	3500	—	Natl
	2	gas-gaso	175	5000	—	B Erie
Toole County						
Treasure State Drlg Co	1	gas	140	3500	4500	B Erie 36-L
NEBRASKA						
Kimball County						
Signal Oilfield Serv	2	gas-btne	215	—	8000	Frnks Rocket
	11	dsl	—	—	8000	Crdwll RL
Richardson County						
Nemaha Oil Co	1(wo)	gas	150	—	4500	Wichtex C-60
NEVADA						
Churchill County						
Barry Well Drlg	3	gaso	85	—	500	Custom
NEW MEXICO						
Chaves County						
Keyes Drlg Co	4	LPG	53	1500	2500	B Erie 24-L
Eddy County						
Collier Drlg Co	1	gas-gaso	145	5000	—	B Erie 36-L
	2	dsl	—	5000	—	Wich 66
	3	gas	175	5000	5000	B Erie 36-L
Donnell Drlg Co	1	gas-btne	—	5000	5000	Wichita 61
Kersey & Company	1	gas-gaso	185	5000	5000	Natl 3
	2	gas-gaso	120	3000	3500	Wich Spdr 55
	3	gas-gaso	120	4000	4500	Wich Spdr 61
	4	gas-gaso	120	4000	4500	Natl 3
Needham Drlg Co	1	dsl	160	5000	—	Wich Spdr 66
	2	LPG	180	5000	—	Wich Spdr 66
Jack Plemons Drlg Co	1	LPG	150	5000	—	Natl
	2	LPG	144	—	4500	B Erie 36-L
S P Yates Drlg Co	3	LPG	150	3500	—	Wichita 55
	4	LPG	130	3000	—	Ft Wrth Spr J
	5	LPG	180	6000	—	Ft Wrth Jumbo J
	6	LPG	180	6000	—	Ft Wrth Jumbo J
Lea County						
Carper Drlg Co Inc	5-C	gas-LPG	125	4000	4500	B Erie 36-L
	6-C	gas-LPG	145	6000	7000	Wlkr-Nr S-55
Gulf Coast Western Oil Co	1	gas	145	5000	6500	Wlkr-Nr C-34
Art West Drlg Co	2	gas	145	—	8000	Crdwll RL
Rio Arriba County						
C L (Cluke) Myers Drlg Co Inc	2	gas-btne	145	4500	7500	Wisn Mogul
San Juan County						
Signal Oilfield Serv	12	dsl	—	—	8000	Crdwll RL
	13	dsl	—	—	8000	Crdwll RL
OHIO						
Hocking County						
R A Cooper Drlg Co	1	gas	—	4000	4000	Natl 12
Wood County						
H J Lininger	2	dsl	175	3500	—	L C Moore
Wyandot County						
H J Lininger	1	gas-gaso	78	2500	—	Beth Cyclone
	3	gas-gaso	65	1800	—	Beth Cyclone
OKLAHOMA						
Alfalfa County						
Sooner Drlg Co	2	LPG	145	5000	7500	Wlkr-Nr
Beaver County						
Chambless-Rosen Drlg Co	2	gas-btne	145	—	10,000	Crdwll RL
Beckham County						
Bolin Oil Co & D H Bolin	8	gas	145	4500	—	Wlkr-Nr S-45
G H Ray Well Serv Co	6	gaso-gas	—	12,000	—	Crdwll S-60
Caddo County						
G H Ray Well Serv Co	1	gaso-gas	—	12,000	—	Wisn Master
	5	gaso-gas	—	12,000	—	Crdwll RL
	7	gaso-gas	—	4500	—	Wilson
	8	gaso-gas	—	—	12,000	Crdwll
Creek County						
4-J Drlg & Well Serv Co	1	gaso	—	—	4500	B Erie 36L
	2	gaso	—	—	3500	Wlkr-Nr
C H Hartman	1	—	—	3500	—	—
M L (Mike) Marrs Drlg Co	1	LPG	145	3500	4500	B Erie 36-L
	2	LPG	145	3500	5000	B Erie 36-L
	3	LPG	145	3500	5000	B Erie 36-L
	4	LPG	145	3500	5000	B Erie 36-L
Porter Drlg Co	1	gas-LPG	—	3500	—	Wlkr-Nr S-32
Skinner & McDougal Drlg Co	2	gaso-btne	145	4000	5500	Wlkr-Nr
Garfield County						
Hayward Drlg Co	2	gas	145	4000	—	Brwstr
Grant County						
Sooner Drlg Co	4	LPG	145	5000	7500	Wlkr-Nr
Kay County						
Bodard Drlg Co	2	gas	225	7000	7000	Wlkr-Nr C-34
Mora Drlg Co	4	gas	300	7000	—	Wisn Giant
Dave Morgan Drlg Co	—	LPG-gas	145	—	6500	Crdwll RL
Lincoln County						
Foster Drlg Co	1	prop	135	—	3500	Cooper
	3	prop	135	—	4000	Wlkr-Nr
Logan County						
Chambless-Rosen Drlg Co	4	gas-btne	145	—	10,000	Crdwll RL
Muskogee County						
Ralph G Ladd	1	gas-gaso	65	1750	2500	Star Spdr K
Noble County						
Chambless-Rosen Drlg Co	3	gas-btne	145	—	10,000	Crdwll RL
Nowata County						
Bennett Drlg Co	6	LPG	—	1750	2250	B Erie 24-L
	10	LPG	—	2000	2500	B Erie 60-L
Okfuskee County						
Floyd R Hyer	—	—	—	2200	—	Star Spdr K
Skinner & McDougal Drlg Co	3	gaso-btne	145	4000	5500	Crdwll
Oklahoma County						
H E R Drlg Co	1	gas-btne	350	6000	—	Ideco
	2	dsl	200	3500	7000	Franks
Okmulgee County						
D & J Drlg Co	—	btne	140	5000	5000	45 Star Spdr
Gold-Mar Drlg Co	1	LPG	125	2500	3500	Wich Spdr 25
Muzny Drlg Co	1	gas-gaso	145	4500	6000	Ft Wrth D
	2	gas-gaso	65	1200	1600	Ft Wrth U
Skinner & McDougal Drlg Co	1	gaso-btne	145	4000	6500	Crdwll
Osage County						
Bennett Drlg Co	5	LPG	—	2750	3250	B Erie 28-L
	8	LPG	—	2750	3250	B Erie 28-L
	9	LPG	—	3500	4500	Wlkr Nr-34
W C Holt Drlg Co Inc	1	gas	130	3000	4000	Wlkr-Nr
Bob Murphy Drlg Contr	1	LPG	140	3000	3500	B Erie 28-L
	2	LPG	140	4000	5000	B Erie 36-L
Tolson Drlg Co	1	LPG	145	4000	5000	Wlkr-Nr S-33

Contractor's Name	Rig No.	Type Power	HP of Driving Engine	Top of Bottom Drlg Cap.	Workover and Cleanout Depth Cap.	Rig Make and Model
Payne County						
Mora Drlg Co	1	dsl	250	5000	—	Wlsn Mogul
Pottawatomie County						
Sooner Drlg Co	6	gas-LPG	145	—	6500	Crdwll RL
Rogers County						
Bennett Drlg Co	3	LPG	—	2750	3250	B Erie 28-L
Seminole County						
E & M Well Serv Co	3	LPG	450	—	5500	Franks
	4	LPG	450	—	5500	Franks
	5	LPG	450	—	5500	Franks
Mora Drlg Co	6	dsl	250	5000	—	Wlsn Mogul
C L (Cluke) Myers Drlg Co Inc	1	gas-btne	145	6500	11,000	Crdwll RL
Troup & Suttles Inc	1	gas-gaso	145	—	9000	Wlkr-Nr 33
Triple E Drlg Co	1	LPG	145	—	800	Crdwll
	2	gaso	110	—	4000	Franks
Stephens County						
Thompson Drlg Co	1	LPG	150	1500	2000	Extell
Texas County						
Dunnam & Wyant Drlg Co	1	LPG	145	—	8000	Crdwll RL
Tulsa County						
Bar-Lee Drlg Co	1	LPG	120	3000	3500	Wlkr-Nr-32
Bennett Drlg Co	2	LPG	—	3500	4000	Star 45
J M Corbett	1	gas	—	5000	6500	Ft Wrth
J M C Drlg Interests	2	gas	—	1500	—	Keystone
Mora Drlg Co	7	gas	200	3500	—	Natl T-12
Washington County						
H & S Drlg Co (Dewey)	1	gas	90	3000	—	—
	2	gas	60	2000	—	—
	3	gas	140	4000	—	B Erie 36-L
K & S Drlg Co	1	LPG	—	2500	—	B Erie 28-L
	2	LPG	—	2500	—	B Erie
R W Uhl	1	gas-gaso	—	2500	3000	B Erie 28-L
PENNSYLVANIA						
Clearfield County						
Fairman Drlg Co	1	dsl	225	7500	8000	B Erie Spdr 48-L
	2	dsl	225	7500	8000	B Erie Spdr 48-L
	3	gas	225	7500	8000	B Erie Spdr 48-L
	4	gas	225	7500	8000	B Erie Spdr 48-L
Greene County						
Cecil Chisler & Son	2	gas-gaso	145	5000	5000	B Erie Spdr 36-L
Indiana County						
Fairman Drlg Co	5	dsl	170	5000	6000	B Erie Spdr 36-L
TEXAS						
Andrews County						
Western Drlg Co Inc	2	btne	145	—	—	B Erie 36-L
Archer County						
Ayers & Burch	1	btne	100	1500	—	Wlkr-Nr
Ramey Well Serv	1	LPG	140	—	8000	Wichtex E-75
	2	LPG	140	—	8000	Wichtex E-75
Baylor County						
Lin-Mour Drlg Co	2	gas	125	—	6500	Wlkr-Nr C-34
Brewster County						
Buck Jones Drlg Co	1	btne	140	4000	4000	Wlkr-Nr 33
Carson County						
J R McGill	1	gas-gaso	—	—	—	B Erie
	2	gas-gaso	—	—	—	B Erie
Cochran County						
Western Drlg Co Inc	3	btne	145	—	—	B Erie 36-L
	4	btne	185	—	—	B Erie 48-L
Coleman County						
Oney Drlg Co	3	gas	210	6500	—	Wichita
Comanche County						
Choate & Hitt	1	LPG	150	4000	5000	Ft Wrth S J
Cooke County						
Russell & Russell Drlg & Prod Co	1	gaso	80	2500	2500	Ft Wrth Spr H
Crockett County						
Brown & Thorp Drlg Co	3	LPG	180	4000	—	Ft Wrth F-37
Culberson County						
Ford Chapman Drlg Contr	2	LPG	225	7000	8500	B Erie 48-L
Ector County						
Eastland Drlg Co	6	gas	125	4500	6000	B Erie
McQueen & Stout Drlg Co	16	LPG	185	5000	5000	Crdwll RL
	18	LPG	145	5000	—	Natl 3
Art West Drlg Co	1	gas	185	—	8000	Crdwll RL
	6	gas	185	—	9000	Wlsn Giant
	7	dsl	125	—	8000	Crdwll RL

Contractor's Name	Rig No.	Type Power	HP of Driving Engine	Top to Bottom Drlg Cap.	Workover and Cleanout Depth Cap.	Rig Make and Model
Gray County						
C P Drlg Co	6	gas-btne	125	3500	4000	Wlsn Mogul
	8	gas-btne	125	3500	4000	B Erie 36-L
C F Hills Drlg Co	3	gas-btne	145	6000	7800	Wlkr-Nr C-34
Murphy & McKennan	1	gas-gaso	145	4500	5500	B Erie 36-L
	2	gas-gaso	145	4500	5500	B Erie 36-L
Guadalupe County						
C & S Drlg Co	2	gaso	110	1800	2000	Axtel 10
Howard County						
C D Turner Drlg Co	1	btne	145	3500	8000	Wlkr-Nr C-37
Hutchinson County						
Graham-Michaelis Drlg Co	4	dsl	175	—	4000	Crdwll KL
C F Hills Drlg Co	2	gas-btne	145	5000	9000	Wlkr-Nr S-33
Holt Bros Drlg Co	1	gas-btne	—	4000	—	B Erie 36-L
Jones County						
Jones Well Serv Co	1	gas-gaso	175	3500	6000	B Erie 36-L
	2	gas-gaso	175	3500	6000	B Erie 36-L
Lubbock County						
Western Drlg Co Inc	8	btne	185	—	—	B Erie 48-L
Maverick County						
Errol Elkins Drlg Co	1	LPG	150	5000	6500	B Erie 36-L
	2	LPG	150	5000	6500	B Erie 36
W H McGarr Ind	1	gas-LPG	120	4500	4500	Wich 61
	2	gas-LPG	100	2500	2500	Ft Wrth Spr D
Louis Pitcock Drlg Co	1	dsl	225	6000	7000	Wich 66
Western Drlg Co Inc	7	dsl	185	—	—	B Erie 48-L
Mitchell County						
Hissom Drlg Co	5	gas	180	7500	10,000	Crdwll RL
G S Taylor & Son Drlg	3	LPG	120	3500	—	Wlkr-Nr S-32S
Reeves County						
Ford Chapman Drlg Contr	1	LPG	120	4500	5500	B Erie 36-L
Scurry County						
G S Taylor & Son Drlg	4	LPG	120	3500	—	Wlkr-Nr S-43
Shackleford County						
J Conley Miles Drlg Co	1	btne	114	2500	3500	Ft Wrth D
	2	btne	100	1750	2500	B Erie 24-L
W H Varner Drlg Co	1	btne	150	—	—	Wlsn Spr
	1	gaso	75	1500	—	B Erie 22-W
Sherman County						
C P Drlg Co	3	gas-btne	125	3500	4000	B Erie 36-L
Stephens County						
Choate & Hitt	1	LPG	185	5000	6500	Ft Wrth J J
Jones Well Serv Co	3	gas-gaso	175	3500	6000	B Erie 36-L
Jack L Story	5-1	dsl	100	8000	9000	Wlkr-Nr C-37
Sutton County						
Saunders Drlg Inc	1	LPG	70	2500	3000	B Erie 28-L
Taylor County						
West Central Drlg Co	2	gas-gaso	—	—	—	Ft Wrth J
Upton County						
Brown & Thorp Drlg Co	2	LPG	135	5500	—	Wichita 66
	4	LPG	135	4000	—	Ft Wrth F
	5	LPG	135	4000	—	Ft Wrth D
	6	LPG	180	4000	—	Ft Wrth F
	7	LPG	135	4500	—	Wichita 61
	8	LPG	135	3500	—	Ft Wrth D
	9	LPG	135	3500	—	Ft Wrth D
	10	LPG	135	3500	—	Wichita 55
	11	LPG	135	3500	—	Ft Wrth D
Buck Jones Drlg Co	2	btne	100	2500	2500	Wlkr-Nr 32
	3	btne	150	5000	5000	Natl 3
McQueen & Stout Drlg Co	20	LPG	185	5000	5000	Crdwll RL
Ward County						
Hatfield Drlg Co Inc	1	dsl	240	8500	10,000	Crdwll
	2	gas	140	5000	7500	Crdwll
	3	gas	145	8500	10,000	Crdwll
Art West Drlg Co	3	gas	145	—	8000	Crdwll RL
	4	gas	145	—	8000	Crdwll RL
Williamson County						
C & S Drlg Co	1	gaso	120	2000	2300	Ft Wrth Spr D
Winkler County						
R L Bob Clark Drlg Contr	2	LPG	90	3500	4500	B Erie
	3	LPG	130	3500	4500	B Erie
Donnell Drlg Co	2	gas-btne	—	5000	5000	Wichita 61
	3	gas-btne	—	5000	5000	Wichita 55
Art West Drlg Co	5	gas	145	—	6000	Crdwll KL
Young County						
Oney Drlg Co	1	gas	165	5500	—	Wichita
	2	gas	145	5500	—	Wichita
	4	gas	145	5500	—	Ft Wrth
Stephens Oil & Gas Corp	11	gas	145	—	7000	Wlkr-Nr C-34

Contractor's Name	Rig No.	Type Power	HP of Driving Engine	Top to Bottom Drlg Cap.	Workover and Cleanout Depth Cap.	Rig Make and Model
WEST VIRGINIA						
Fayette County						
Allen Drlg Co	7	gas	175	3500	5000	Natl Mach 2
Logan County						
Allen Drlg Co	2	gas	145	5000	6000	B Erie Spdr 36-L
	3	gas	128	5000	6000	B Erie Spdr 36-L
Mingo County						
Allen Drlg Co	1	gas	128	5000	6000	B Erie Spdr 36-L
Wetzel County						
Cecil Chisler & Son	1	gas-gaso	78	3500	3500	B Erie Spdr 28-L

Contractor's Name	Rig No.	Type Power	HP of Driving Engine	Top to Bottom Drlg Cap.	Workover and Cleanout Depth Cap.	Rig Make and Model
WYOMING						
Big Horn County						
Morrison Drlg Co Inc (Wyo)	4	btne	185	5500	8000	Crdwll
Natrona County						
Morrison Drlg Co Inc (Wyo)	1	btne	145	4500	6000	Crdwll
	3	btne	185	5500	8000	Crdwll
Sweetwater County						
Morrison Drlg Co Inc (Wyo)	2	btne	185	5500	8000	Crdwll

CANADIAN DRILLING CONTRACTORS

ROTARY AND CABLE TOOLS

ALPHABETICAL LISTING

Able Drlg Co
Three Hills Alberta Canada

Arrow Drlg Co
201 Oil Exchange Bldg
Calgary Alberta Canada

Peter Bawden Drlg Ltd
810-A First St W
Calgary Alberta Canada

Big Horn Drlg Ltd
6530 100th St
Edmonton Alberta Canada

Brinkerhoff Drlg Co Ltd
1001 Mobil Oil Bldg
Calgary Alberta Canada

Brown Drlg Ltd
10509 81st Ave
Edmonton Alberta Canada

Cactus Drlg Corp Ltd
Box 853
Calgary Alberta Canada

Calgary Oil Field Serv Ltd
133 Sixth Ave SE Rm 201
Calgary Alberta Canada

Can American Drlg Ltd
133 Sixth Ave E
Calgary Alberta Canada

Can-Tex Drlg Co Ltd
239 Sixth Ave W
Calgary Alberta Canada

Cardinal Drlg Co
Elks Office Bldg
Bismarck N D

Cascade Drlg Co Ltd
330 Ninth Ave W
Calgary Alberta Canada

Central Leduc Drlg Co Ltd
224 Ninth Ave W
Calgary Alberta Canada

Commonwealth Drlg Co Ltd
122 Eighth Ave W
Calgary Alberta Canada

Coralta Drlg Ltd
Box 4104
Edmonton Alberta Canada

Coultis Drlg Ltd
1724 Suffolk St
Calgary Alberta Canada

Dallas Drlg Co Ltd
1208 First Natl Bank Bldg
Dallas Tex

Devon Drlg Co Ltd
703 Fifth St W
Calgary Alberta Canada

Double "A" Drlg Co Ltd
709 Eighth Ave W
Calgary Alberta Canada

Duke Drlg Co Ltd
239 8th Ave W
Calgary Alberta Canada

Eakle & Holder Drlg Co
116 Mulberry St
Evansville Ind

El Centro Drlg Ltd
905-A 8th Ave
Calgary Alberta Canada

Gardner Bros Drlg Co Inc
1708 Davis Bldg
Dallas Tex

General Petroleum of Canada Ltd
224 Ninth Ave W
Calgary Alberta Canada

Gustavson Drlg Co Ltd
203 Empire Bldg
Calgary Alberta Canada

Paul Guthrie Development
9916 109 St
Edmonton Alberta Canada

Hewgley Drlg Co
704 Wilco Bldg
Midland Tex

Hi-Tower Drlg Co Ltd
400 Lancaster Bldg
Calgary Alberta Canada

Hunter Drlg Ltd
602 Seventh Ave W
Calgary Alberta Canada

Jennings Drlg Co (Alberta) Ltd
133 Sixth Ave SE Rm 201
Calgary Alberta Canada

Kenyon's Drlg Serv Co Ltd
10439 82nd Ave
Edmonton Alberta Canada

Loffland Bros Co
Box 1649
Tulsa Okla

Lohmann-Johnson Drlg Co Ltd
208 Bamlett Bldg
Calgary Alberta Canada

Moore Drlg Co Ltd
6th Floor Petroleum Bldg
Calgary Alberta Canada

Oil Producers Ltd
222 Tegler Bldg
Edmonton Alberta Canada

Parker Drlg Co of Canada Ltd
409 8th Ave W
Calgary Alberta Canada

Patterson & Culver
Box 92
Dunnville Ontario Canada

Pennant Drlg Ltd
108-A 8th Ave W
Calgary Alberta Canada

Precision Drlg Co Ltd
1134 8th Ave W
Calgary Alberta Canada

Reading & Bates Drlg Co Ltd
Royal Bk Bldg
Calgary Alberta Canada

Regent Drlg Co Ltd
Box 421
Edmonton Alberta Canada

Rine Drlg Co of Canada Ltd
436 Longhead Bldg
Calgary Alberta Canada

Ryland Drlg Ltd
10318 82nd Ave
Edmonton Alberta Canada

S & T Drlg Co Ltd
10824-A 82nd St
Edmonton Alberta Canada

Teton Drlg Co Ltd
Box 2068
Casper Wyo

Thornton & Bates Drlg Co
Royal Bk Bldg
Calgary Alberta Canada

Trident Drlg Co Ltd
830 8th St W
Calgary Alberta Canada

Trinity Canadian Drlg Co
1001 F R Webster Bldg
237 7th Ave W
Calgary Alberta Canada

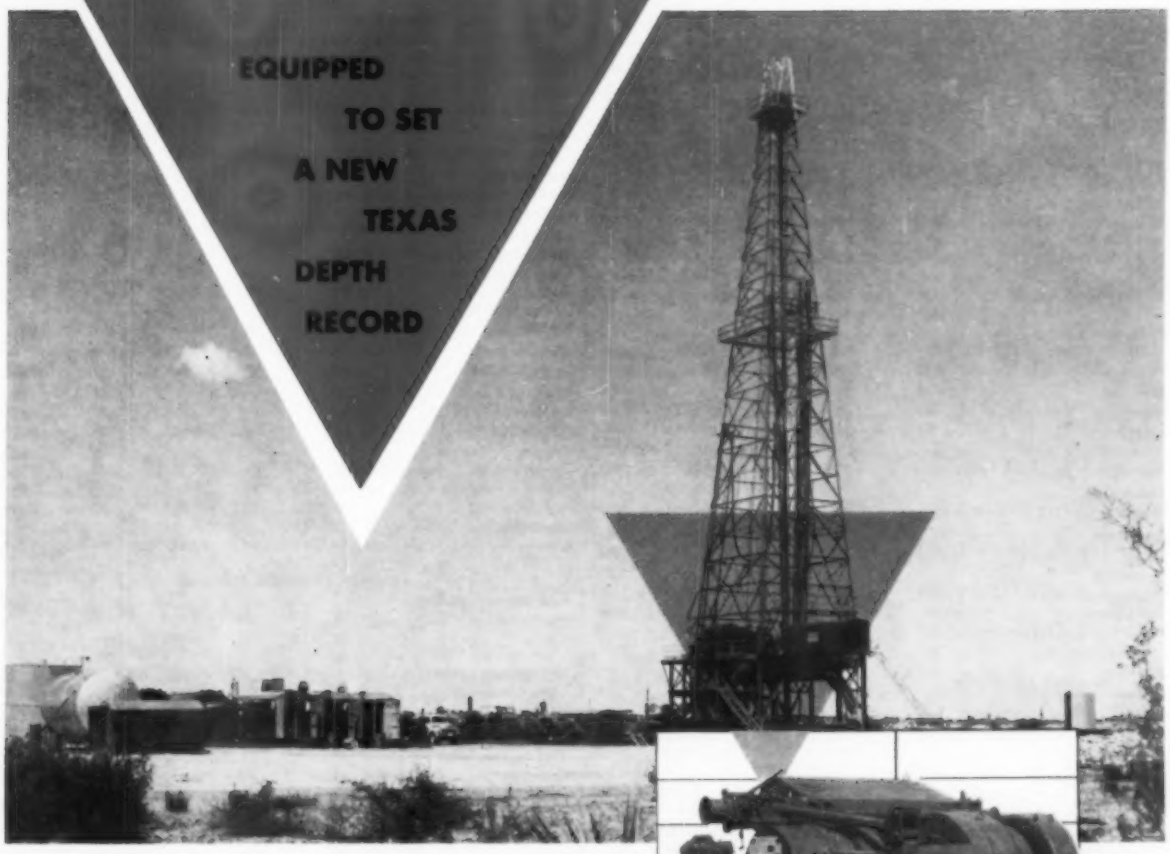
Tri-Province Drlg Co Ltd
719 Bamlett Bldg
Calgary Alberta Canada

Union Rotary Drlrs (Canada) Ltd
155 Wellington St
Sarnia Ontario Canada

Wilrich Drlg Ltd
10584 107th St
Edmonton Alberta Canada

Canadian Contract ROTARY Drilling Rigs

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
ALBERTA PROVINCE						
Calgary Oil Field Serv Ltd	1	dsl	120	Wisn Spr 38	180	10,000/2½"
	2	dsl	120	Wisn Spr 38	180	10,000/2½"
Can-Tex Drlg Co Ltd	3	—	—	Emsco GB-800	—	12,000
	4	—	—	Crdwll OC	—	8,000
	5	—	—	"Oilwell" 66	—	8,000
	6	—	—	Emsco GA-500	—	8,000
	7	—	—	"Oilwell" 64B	—	7,500
	8	—	—	Natl T-25	—	5,500
	9	—	—	Crdwll OT	—	7,000
	10	—	—	Emsco J-1100	—	15,000
	12	—	—	Emsco GB-800	—	12,000
Jennings Drlg Co (Alberta) Ltd	1	dsl	225	Beth C-50	225	6,500/3½"
	2	dsl	225	Beth C-50	225	6,500/3½"
Alder Flats						
Trident Drlg Co Ltd	1	dsl	—	"Oilwell" 64B	640	5,000
	3	dsl	—	"Oilwell" 64B	640	5,000
	12	dsl	—	Unit U-15	640	7,500
Barons						
Devon Drlg Co Ltd	1	dsl	700	Emsco GA-500	500	9,500
Bellshill Lake						
Big Horn Drlg Ltd	1	dsl	300	Crdwll S-350	250	5,000
Bantley						
Cascade Drlg Co Ltd	4	dsl	—	Natl 50-A	—	7,500
Commonwealth Drlg Co Ltd	16	dsl	560	Emsco GB-350	450	6,500
Regent Drlg Co Ltd	6	dsl	750	Brwstr N-75	780	10,000
Big Valley						
Tri-Province Drlg Co Ltd	4	dsl	520	Emsco GA-350	520	6,000
Black Diamond						
Commonwealth Drlg Co Ltd	7	dsl	750	Natl 50	530	6,500
Blackie						
Pennant Drlg Ltd	2	dsl	1155	Brwstr N-7	755	8,500
Blue Ridge						
Hi-Tower Drlg Co Ltd	4	dsl	350	Natl 50	450	6,500
	8	dsl	570	Unit U-15	600	8,000
Boha Lake						
Wilrich Drlg Ltd	4	dsl	110	Failing 2500	110	3,000/3½"
Breton						
Arrow Drlg Co	8	dsl	250	Emsco GB-350	350	7,000
	19	dsl	250	Emsco GB-350	350	7,000
S & T Drlg Co Ltd	2	dsl	440	Natl T-32	270	6,000
	3	dsl	900	Natl 55	900	9,000
Buck Creek						
Regent Drlg Co Ltd	26	dsl	260	Ideco H-40	260	6,000
Thornton & Bates Drlg Co	5	dsl	375	Natl 50-A	600	7,000
Buck Lake						
Moore Drlg Co Ltd	6	dsl	400	Emsco 300	300	6,000
Ryland Drlg Ltd	4	dsl	450	Emsco 350	475	7,000
Butte						
Commonwealth Drlg Co Ltd	27	dsl	870	Natl 50-A	660	8,000
Calgary						
Duke Drlg Co Ltd	8	dsl	500	Unit U-40	670	10,000
Parker Drlg Co of Canada Ltd	12	dsl	600	"Oilwell" 66	670	9,000
Calmar						
Gustavson Drlg Co Ltd	4	dsl	850	Natl 55	850	10,000
Cardston						
Brinkerhoff Drlg Co Ltd	22	dsl	900	Natl 110	1450	15,000
General Pet of Canada Ltd	17	dsl	1400	Natl 55	1050	10,000
Carseland						
Cascade Drlg Co Ltd	15	dsl	—	"Oilwell" 64B	—	6,000
Coalspur						
Loffland Bros Co	C-4	dsl	1000	—	1275	15,000
Cochrane						
Duke Drlg Co Ltd	5	dsl	700	Unit U-20	1386	13,500
Cold Lake						
Kenyon's Drlg & Serv Ltd	11	dsl	—	Crdwll 151	—	5,000/3½"
Coronation						
Coralta Drlg Ltd	2	gas	180	Failing 1500	180	1,500/2⅛"
Wilrich Drlg Ltd	2	dsl	—	Natl T-12	160	3,500/3½"
Crossfield						
Able Drlg Co	20	gas	46	Mayhew	—	1,000/2⅛"
Moore Drlg Co Ltd	1	dsl	1000	Unit U-40	1000	10,000
Cynthia						
Loffland Bros Co	C-2	dsl	600	—	600	9,000
Czar						
Paul Guthrie Development	2	dsl	500	"Oilwell" T-52	350	7,500
Didsbury						
Trident Drlg Co Ltd	9	dsl	—	"Oilwell" 76	960	10,000
Drayton Valley						
Duke Drlg Co Ltd	2	dsl	650	Natl 50	650	8,000
Hi-Tower Drlg Co Ltd	5	dsl	350	Natl 50	450	5,000
S & T Drlg Co Ltd	1	dsl	520	Natl 50-A	520	8,000
Edmonton						
Cactus Drlg Corp Ltd	3	dsl	420	Natl T-32	280	6,000
Coralta Drlg Ltd	1	gas	180	Failing 1500	180	1,500/2⅛"
Hewgley Drlg Co	3	dsl	—	Emsco J-750	975	10,000
Edson						
Arrow Drlg Co	21	dsl	600	Emsco J-1250	1400	14,000
Parker Drlg Co of Canada Ltd	3	dsl	765	"Oilwell" 76	1005	12,000
Regent Drlg Co Ltd	25	dsl	750	Brwstr N-75	780	10,000
Trident Drlg Co Ltd	8	dsl	—	"Oilwell" 96	1920	15,000
Elkton						
Regent Drlg Co Ltd	7	dsl	1200	Natl 125	1500	15,000
Garrington						
General Pet of Canada Ltd	16	dsl	1050	Natl 55	1150	10,000
Grande Prairie						
Commonwealth Drlg Co Ltd	19	dsl	735	Natl 50-A	790	8,000
Parker Drlg Co of Canada Ltd	2	dsl	615	"Oilwell" 76	750	11,000
	10	dsl	400	Natl 50-A	500	7,000
Regent Drlg Co Ltd	9	dsl	750	Brwstr N-75	780	10,000
Trident Drlg Co Ltd	10	dsl	—	Emsco GB-350	510	6,500
Hardisty						
Big Horn Drlg Ltd	2	dsl	250	Crdwll L	180	3,500
Harmattan						
Commonwealth Drlg Co Ltd	26	dsl	1275	Natl 80-B	1410	12,000
	28	dsl	920	Natl 55	1000	10,000
General Pet of Canada Ltd	15	dsl	1400	Natl 55	1050	10,000
Hines Creek						
Trident Drlg Co Ltd	14	dsl	—	"Oilwell" 76	960	10,000
Innisfail						
Brinkerhoff Drlg Co Ltd	1	dsl	625	Emsco GC-500	846	10,000
General Pet of Canada Ltd	11	dsl	1400	Natl 80-B	1150	12,000
Hi-Tower Drlg Co Ltd	1	dsl	525	"Oilwell" 66	550	8,000
	10	dsl	755	"Oilwell" 76	800	12,000
Parker Drlg Co of Canada Ltd	1	dsl	615	"Oilwell" 76	750	11,000
Tri-Province Drlg Co Ltd	1	dsl	1000	Unit U-40	850	11,000
Joffre						
Brown Drlg Ltd	2	dsl	550	Natl 50	550	7,500
Cascade Drlg Co Ltd	9	dsl	—	Natl T-32	—	5,500
Kevisville						
Gardner Bros Drlg Co Inc	7	dsl	850	Natl 75	1000	12,000
Keystone						
Peter Bawden Drlg Ltd	1	dsl	415	Natl T-32	275	5,500
	5	dsl	440	Natl T-32	270	5,500
Brown Drlg Ltd	1	dsl	275	Crdwll S	—	5,000
General Pet of Canada Ltd	6	dsl	400	Natl 50-A	500	7,000
Regent Drlg Co Ltd	1	dsl	260	Brwstr N-4	260	6,000
	28	dsl	500	Natl 50-A	520	7,000
Rine Drlg Co of Canada Ltd	2	dsl	590	Brwstr N-55	720	8,500
Lethbridge						
Wilrich Drlg Ltd	6	dsl	300	Unit U-34	300	6,000
Lloydminster						
Oil Producers Ltd	3	dsl	100	Crdwll K	142	3,000
Ma-Me-O Beach						
Trident Drlg Co Ltd	7	dsl	—	"Oilwell" 76	960	10,000
Mundare						
Paul Guthrie Development	1	dsl	300	"Oilwell" T-32	350	7,000
Nacmine						
Commonwealth Drlg Co Ltd	8	dsl	690	Brwstr N-7	600	8,000
Nanton						
Trident Drlg Co Ltd	4	dsl	—	Natl 100	1200	13,000
Nordegg						
Cascade Drlg Co Ltd	12	dsl	—	Natl 80-B	—	14,000
Normandville						
Gustavson Drlg Co Ltd	5	dsl	420	Natl T-32	275	6,500
Panther River						
Duke Drlg Co Ltd	7	dsl	850	Unit U-20	1386	13,500
Pembina						
Brinkerhoff Drlg Co Ltd	20	dsl	370	Natl 50-A	450	8,500
Cascade Drlg Co Ltd	1	dsl	—	Natl 50	—	6,500
	3	dsl	—	Natl 50	—	6,500
	8	dsl	—	Natl 50	—	6,500



The rig now drilling toward a new Texas depth record of 22,000 ft. in Pecos County is equipped with a U-1220 electric draw works.

The choice of equipment for this deep test was of primary importance. In selecting the U-1220 draw works, the contractor has assured the operators speed of operation, minimum down time, and dependable performance.

Simplicity of operation and ease of maintenance are design characteristics of the unit. The U-1220-EB Electra-Flow Draw Works is available in a single or split package. Included among other important features are extra large diameter and wide spooling drum, large braking capacity, and centralized lubrication.

You can depend upon a Unit Rig draw works to turn in an outstanding performance—anywhere—because it is "designed for the job."

THE U-1220-EB
ELECTRA-FLOW
DRAW WORKS

UNIT RIG and EQUIPMENT CO.
Box 1889, Tulsa, Okla.
Export Sales: MID-CONTINENT SUPPLY CO.
45 Rockefeller Plaza, New York 20, N. Y.
Cable: MIDUNITRIG

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Commonwealth Drlg Co Ltd	3	dsl	690	Natl 50	600	6,500
	17	dsl	400	Emsco GB-350	465	6,000
Double "A" Drlg Co Ltd	2	dsl	800	Ideco H-525	600	8,000
General Pet of Canada Ltd	3	dsl	425	Natl 50-A	650	7,500
	14	dsl	350	Crdwll OA	500	6,500
Gustavson Drlg Co Ltd	1	dsl	500	Natl 50	500	7,500
Hi-Tower Drlg Co Ltd	7	dsl	525	"Oilwell" 66	550	8,000
Parker Drlg Co of Canada Ltd	4	dsl	400	Natl 50	500	6,500
Reading & Bates Drlg Co Ltd	6	dsl	375	Natl 50	675	7,000
Ryland Drlg Ltd	1	dsl	600	Emsco 450	640	7,500
	2	dsl	670	Natl 50	690	7,500
Tri-Province Drlg Co Ltd	2	dsl	520	Beth Twstr S-55	520	7,500
	6	dsl	520	Ideco H-525	520	7,500
Pincher Creek						
Brinkerhoff Drlg Co Ltd	19	dsl	850	Emsco A-800	1269	14,000
Commonwealth Drlg Co Ltd	1	dsl	1350	Natl 110	1500	14,000
Pine rook						
General Pet of Canada Ltd	18	dsl	1400	Natl 80-B	1150	12,000
Ponoka						
Brinkerhoff Drlg Co Ltd	16	dsl	370	Emsco GA-350	450	7,500
Moore Drlg Co Ltd	5	dsl	380	Crdwll EC	380	6,000
Priddis						
Cascade Drlg Co Ltd	14	dsl	—	Unit U-20	—	14,000
Queensville						
Double "A" Drlg Co Ltd	3	dsl	300	Ideco H-40	265	6,000
Red River						
Peter Bawden Drlg Ltd	6	dsl	722	Unit U-36A	722	8,500
Moore Drlg Co Ltd	2	dsl	600	Emsco 450	640	7,000
Parker Drlg Co of Canada Ltd	8	dsl	400	Natl 50	500	6,500
Trident Drlg Co Ltd	13	dsl	—	"Oilwell" 66	640	7,000
Red Earth						
Commonwealth Drlg Co Ltd	11	dsl	260	Ideco H-40	300	5,500
Rimbey						
General Pet of Canada Ltd	4	dsl	500	Natl 50-A	650	7,500
Hi-Tower Drlg Co Ltd	3	dsl	525	"Oilwell" 66	550	8,000
Rosebud						
Gustavson Drlg Co Ltd	3	dsl	275	Ideco H-40	300	6,000
Hi-Tower Drlg Co Ltd	9	dsl	285	Crdwll D	300	5,000
Sarcee						
Commonwealth Drlg Co Ltd	21	dsl	1250	Ideco 7-11	900	10,500
Savannah Creek						
Loffland Bros Co	C-3	dsl	970	—	1275	14,000
	C-5	dsl	1570	—	1275	14,000
Sibbald						
Parker Drlg Co of Canada Ltd	11	dsl	400	Natl 50	500	6,500
Stettler						
Arrow Drlg Co	6	dsl	250	Emsco GB-350	350	7,000
Regent Drlg Co Ltd	30	dsl	260	Ideco H-40	260	6,000
Stolberg						
General Pet of Canada Ltd	7	dsl	1400	Natl 80-B	1300	13,000
Sturgeon Lake						
Commonwealth Drlg Co Ltd	9	dsl	1020	Ideco 700	940	10,000
General Pet of Canada Ltd	5	dsl	800	Natl 80-B	1000	12,000
Sullivan Creek						
Duke Drlg Co Ltd	6	dsl	850	Unit U-20	1386	13,500
Sundre						
Brinkerhoff Drlg Co Ltd	18	dsl	625	Emsco GC-500	846	10,000
General Pet of Canada Ltd	10	dsl	1400	Natl 80	1000	12,000
Parker Drlg Co of Canada Ltd	9	dsl	765	Natl 125	1005	12,000
Pennant Drlg Ltd	6	dsl	1200	Unit U-40	1200	9,500
Reading & Bates Drlg Co Ltd	3	dsl	950	Natl 75	1050	10,000
Swan Hills						
Hi-Tower Drlg Co Ltd	6	dsl	755	"Oilwell" 76	800	12,000
Three Hills						
Able Drlg Co	10	gaso	40	Failing 1500	—	1,500/2⅛"
Cascade Drlg Co Ltd	7	dsl	—	Natl 50-A	—	7,500
Throne						
Big Horn Drlg Ltd	3	dsl	300	Crdwll L-350	300	4,500
Valleyview						
Cascade Drlg Co Ltd	2	dsl	—	Wisn Roadair	—	9,200
Paul Guthrie Development	3	dsl	800	Natl 55	800	9,500
	4	dsl	1100	Unit U-40	1100	12,000
Lohmann-Johnson Drlg Co Ltd	2	dsl	218	Unit U-15	500	8,500
Virginia Hills						
Lohmann-Johnson Drlg Co Ltd	1	dsl	550	"Oilwell" 66	550	7,500
Regent Drlg Co Ltd	8	dsl	750	Brwstr N-75	780	10,000
Vulcan						
Brinkerhoff Drlg Co Ltd	2	dsl	370	Natl 50-A	600	8,000
Warburg						
Regent Drlg Co Ltd	3	dsl	720	Brwstr N-55	520	8,000
Waugh						
Commonwealth Drlg Co Ltd	10	dsl	550	Ideco H-35-D	300	6,500
Westward Ho						
Brinkerhoff Drlg Co Ltd	21	dsl	850	Emsco GB-800	1269	13,500
Loffland Bros Co	C-1	dsl	740	—	900	11,000
Whitecourt						
Peter Bawden Drlg Ltd	2	dsl	750	Natl 55	750	9,500
Cascade Drlg Co Ltd	5	dsl	—	Natl 50-A	—	7,500
Duke Drlg Co Ltd	9	dsl	500	Unit U-15	650	8,500
Pennant Drlg Ltd	1	dsl	775	Unit U-15	775	8,500
Tri-Province Drlg Co Ltd	5	dsl	780	Beth Twstr S-55	520	7,500
Willesden Green						
Regent Drlg Co Ltd	2	dsl	520	Brwstr N-55	520	8,000
Wimborne						
Brinkerhoff Drlg Co Ltd	15	dsl	370	Natl 50-A	450	8,500
Pennant Drlg Ltd	4	dsl	1000	Crdwll 0	650	9,500
Windfall						
Loffland Bros Co	C-6	dsl	1200	—	1200	16,000
Reading & Bates Drlg Co Ltd	4	dsl	950	Natl 80-B	1050	12,000
	9	dsl	350	Natl 50-A	450	7,000
Woodhouse						
Commonwealth Drlg Co Ltd	23	dsl	865	Emsco GC-500	800	8,500
BRITISH COLUMBIA PROVINCE						
Alcan Highway – Mile 95						
Trinity Canadian Drlg Co	4	dsl	990	Natl 80-B	990	12,000
	5	dsl	1250	Emsco A-800	1150	15,000
	7	dsl	875	Emsco GC-500	720	10,000
Alcan Highway – Mile 120						
Trinity Canadian Drlg Co	3	dsl	720	Emsco 350	670	7,000
Alcan Highway – Mile 124						
Trinity Canadian Drlg Co	1	dsl	995	Emsco GC-500	770	10,000
Alcan Highway – Mile 175						
Arrow Drlg Co	7	dsl	600	Emsco GC-500	700	9,000
Alcan Highway – Mile 280						
Reading & Bates Drlg Co Ltd	7	dsl	400	Natl 55-A	700	12,500
Boundary Lake						
Commonwealth Drlg Co Ltd	15	dsl	800	Brwstr N-7	600	8,000
Dawson Creek						
Arrow Drlg Co	26	dsl	600	Emsco GB-800	1200	13,000
Can American Drlg Ltd	3	dsl	750	Natl 80-B	1645	10,000
Reading & Bates Drlg Co Ltd	2	dsl	800	Natl 100	1050	12,000
Ft. Nelson						
Brinkerhoff Drlg Co Ltd	14	dsl	370	Emsco GB-500	600	8,500
Ft. St. John						
Arrow Drlg Co	4	dsl	250	Emsco CB-350	500	7,000
Commonwealth Drlg Co Ltd	20	dsl	1040	Ideco 7-11	900	10,500
	22	dsl	750	Natl 50	530	6,500
Dallas Drlg Co Ltd	1	dsl	578	Emsco GB-500	500	8,000
	2	dsl	578	Emsco GB-500	500	8,000
	3	dsl	500	Emsco GB-350	520	6,500
	4	dsl	500	Emsco GB-250	320	5,000
Devon Drlg Co Ltd	2	dsl	300	Emsco GA-350	350	7,500
	3	dsl	700	Emsco GB-500	500	9,500
Parker Drlg Co of Canada Ltd	7	dsl	600	Natl 55	670	9,000
Pennant Drlg Ltd	3	dsl	600	Crdwll 0	540	7,500
Regent Drlg Co Ltd	5	dsl	720	Brwstr N-7	520	8,000
	24	dsl	720	Brwstr N-7	520	8,000
Trident Drlg Co Ltd	6	dsl	—	Emsco-500	640	8,500
Pouce Coupe						
Parker Drlg Co of Canada Ltd	6	dsl	420	"Oilwell" 52-T	420	6,500
MANITOBA PROVINCE						
Virden						
Peter Bawden Drlg Ltd	4	dsl	220	Crdwll RL	205	4,500
Cascade Drlg Co Ltd	6	dsl	—	Natl T-20	—	4,500
	11	dsl	—	Crdwll D	—	5,500
	16	dsl	250	Unit U-34	250	4,500
Commonwealth Drlg Co Ltd	18	dsl	260	Crdwll RL	170	4,500
Coultis Drlg Ltd	1	dsl	238	Ideco H-25-D	235	4,000
	2	dsl	245	Wisn Mogul	245	4,000
	3	dsl	200	Wgnr Mrhse TD2	200	3,500-3½"
ONTARIO PROVINCE						
Lambton						
Union Rotary Drlrs (Can) Ltd	1	gas-LPG	200	Natl 40	180	4,000
Ojibway						
Eakle & Holder Drlg Co	4	dsl	300	Natl T-20	—	5,500

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Windsor						
Regent Drlg Co Ltd	21	dsl	260	Brwstr N-4	260	5,500
Union Rotary Drlrs (Can) Ltd	6	dsl	552	Natl 50	552	8,500
QUEBEC PROVINCE						
Queensdale						
Kenyon's Drlg & Serv Ltd	12	dsl	—	Frnks Comet 658	—	5,000
SASKATCHEWAN PROVINCE						
Can-Tex Drlg Co Ltd	1	—	—	Crdwll RL	—	5,000
	2	—	—	Crdwll RL	—	5,000
(Eastern)						
Lohmann-Johnson Drlg Co Inc	5	dsl	300	Crdwll S	440	4,500
Alida						
General Pet of Canada Ltd	21	dsl	250	Natl T-20	185	4,600
Arcola						
Moore Drlg Co Ltd	3	dsl	320	Brwstr N-4	190	4,000
Bradwell						
Can American Drlg Ltd	7	dsl	260	Natl T-20	260	4,500
Carnduff						
Commonwealth Drlg Co Ltd	13	dsl	390	Emsco GB-350	450	6,500
Gustavson Drlg Co Ltd	2	dsl	500	Natl T-32	250	6,200
Hunter Drlg Ltd	1	dsl	450	Crdwll	260	6,000
Rine Drlg Co of Canada Ltd	1	dsl	300	Brwstr N-45	350	6,500
Coleville						
Precision Drlg Co Ltd	A	dsl	276	Ideco H-20-D	184	3,500
	8	dsl	276	Ideco 30	276	4,000
Estevan						
Brinkerhoff Drlg Co Ltd	12	dsl	200	Natl T-32	300	6,000
General Pet of Canada Ltd	1	dsl	250	Natl 50	525	6,500
	19	dsl	435	Natl T-32	175	5,500
Parker Drlg Co of Canada Ltd	5	dsl	420	Natl 80	420	7,000
Regent Drlg Co Ltd	4	dsl	260	Brwstr N-4	260	6,000
	22	dsl	260	Brwstr N-4	260	6,000
	23	dsl	260	Brwstr N-4	260	6,000
	27	dsl	260	Brwstr N-4	260	6,000
	29	dsl	260	Brwstr N-4	260	6,000
Frobisher						
Hunter Drlg Ltd	3	dsl	450	Crdwll	260	6,000
Glen Ewen						
Can American Drlg Ltd	5	dsl	375	Natl T-32	320	5,000
Harptree						
Can American Drlg Ltd	2	dsl	650	Natl T-55	975	7,500
Instow						
Peter Bawden Drlg Ltd	3	dsl	270	Crdwll 8	180	4,500
Kingsford						
Commonwealth Drlg Co Ltd	5	dsl	260	Emsco GB-250	310	5,000
Kisbey						
General Pet of Canada Ltd	12	dsl	250	Natl T-20	250	4,600
Lampman						
Commonwealth Drlg Co Ltd	6	dsl	690	Ideco M-750	600	7,000
	12	dsl	260	Natl T-32	300	5,500
	14	dsl	430	Ideco H-40	300	5,500
Precision Drlg Co Ltd	C	dsl	276	Natl T-20	276	5,000
Minton						
Tri-Province Drlg Co Ltd	3	dsl	1040	Ideco 7-11	880	11,000
Nottingham						
Moore Drlg Co Ltd	4	dsl	330	Emsco 300	300	3,500
Oxbow						
Cardinal Drlg Co (Bismarck)	—	dsl	320	Natl T-20	320	5,000
Commonwealth Drlg Co Ltd	4	dsl	260	Crdwll RL	170	4,500
Ryland Drlg Ltd	3	dsl	320	Natl T-32	320	6,000
Ralph						
Commonwealth Drlg Co Ltd	24	dsl	520	Natl 50	600	6,000
Ratcliffe						
Central Leduc Drlg Co Ltd	1	dsl	500	Natl 50	500	6,500
Saskatoon						
Can American Drlg Ltd	6	dsl	275	Natl T-12	260	3,000
Shaunavon						
Precision Drlg Co Ltd	E	dsl	450	Ideco 525	550	7,000
(Southeastern)						
Cactus Drlg Corp Ltd	1	gas-btne	450	Brwstr N-55	450	7,000
	2	gas-btne	675	Unit U-15	675	8,500
Steelman						
Commonwealth Drlg Co Ltd	25	dsl	425	Unit U-34D	300	5,500
General Pet of Canada Ltd	2	dsl	250	Unit U-34	250	4,800
	9	dsl	375	Natl T-25	250	5,500
Precision Drlg Co Ltd	6	dsl	550	Ideco H-30-D	276	5,000
Reading & Bates Drlg Co Ltd	1	dsl	300	Natl 50-A	700	7,000
Stoughton						
Can American Drlg Ltd	1	dsl	350	Natl T-32	275	5,000
Success						
Precision Drlg Co Ltd	B	dsl	276	Ideco H-30	276	5,000
Swift Current						
Precision Drlg Co Ltd	D	dsl	276	Brwstr N-4	276	5,000
Tupaske						
El Centro Drlg Ltd	1	dsl	285	Crdwll 0	250	8,000
Wapella						
Precision Drlg Co Ltd	1	dsl	276	Ideco H-30-D	276	5,000
Watrous						
Can American Drlg Ltd	4	dsl	260	Natl T-20	260	4,000
Weyburn						
Central Leduc Drlg Co Ltd	2	dsl	285	Crdwll TR 66	245	5,000
Commonwealth Drlg Co Ltd	2	dsl	550	Natl 50	420	6,500
General Pet of Canada Ltd	8	dsl	250	Natl T-25	250	5,000
Hunter Drlg Ltd	2	dsl	275	Crdwll	260	6,000
Teton Drlg Co Ltd	1	—	—	—	—	—
Wilmar						
General Pet of Canada Ltd	20	dsl	275	Emsco GB-250T	275	5,000

Canadian Cable Tools

Contractor's Name	Rig No.	Type Power	HP of Driving Engine	Top to Bottom Drlg Cap.	Workover and Cleanout Depth Cap.	Rig Make and Model
ALBERTA PROVINCE						
Lloydminster						
Oil Producers Ltd	1	gaso	69	—	4000	Crdwll M
	2	gaso	87	—	3000	Crdwll Q
ONTARIO PROVINCE						
Haldimand						
Patterson & Culver	2	gas	60	2500	—	Natl 2
Norfolk						
Patterson & Culver	1	gas	80	2500	3500	B Erie 28-L
	3	gas	60	1500	2000	B Erie 24-L

SOME CONTRACT RIGS IN FOREIGN SERVICE

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
ALASKA						
Kenai Peninsula						
Coastal Drlg Co	3	dsl	1000	Emsco A-800	1650	13,000
BRITISH HONDURAS						
Kerr-McGee Oil Ind Inc	14	dsl	695	Natl 50	630	9,000
	50	dsl	1000	Natl 55	770	10,000
CUBA						
C J Simpson Drlg Co	1C	dsl-gas	—	Natl T-32	320	5,000
	2C	dsl-gas	—	Unit U-40	900	14,000
	3C	dsl-gas	—	Emsco D-450	700	8,500
Caibarien						
C G Glasscock Drlg Co	3	dsl	1500	Emsco J-1250	—	17,000

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
ITALY						
Abruzzo						
Compagnia Industrie Metanifere E Affini (Rome, Italy)	2	dsl	260	Ideco H-30	300	4 500
Romagna						
Compagnia Ind Metanifere E Affini (Rome, Italy)	1	dsl	900	Ansaldo 2000	600	7,000
JORDAN						
Amman, Hashemite Kingdom						
Parker Drlg Co	46	gas	—	Natl L-75	700	10 000
MEXICO						
Del Mar Drlg Co	3	gas	690	Natl 75	750	10,500
NORTH AFRICA						
Libya						
Camdrill International Inc	—	dsl	255	Ideco H-30-D	300	4 500
	2	dsl	1000	Natl 110	2400	13,000
Delta Drlg Co	1	dsl	1250	Emsco A-800	900	11,000
PAKISTAN						
Southeastern Asia Drlg Co	24	dsl	1200	"Oilwell" 96	1600	18,000
SICILY						
Armerina						
Compagnia Ind Metanifere E Affine (Rome, Italy)	4	dsl	900	Emsco 800	900	11,000
Francofonte						
Compagnia Ind Metanifere E Affine (Rome, Italy)	3	dsl	500	Emsco GB-500	500	8,500

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
TURKEY						
Clyde Hall Drlg Co Inc	8	dsl	600	Beth M-58	600	9,000
VENEZUELA						
Loffland Bros Co	37	gas	1050	—	1300	15,000
(Eastern)						
Perforaciones Delta CA (Caracas, Venezuela)	1	dsl	260	Ideco H-40-D	400	6,500
	2	dsl	260	Ideco H-40-D	400	6,500
	3	dsl	260	Failing 2066	—	—
	5	stm	1200	Emsco UBLS	1690	15,000
	6	dsl	260	Ideco H-40-D	400	6,500
	7	dsl	260	Ideco H-30-D	300	4,500
	10	dsl	260	Crdwll 0	450	7,500
Gulf of Paria						
Perforaciones Delta CA	12	dsl	1560	Emsco J-1250	1250	15,000
Lake Maracaibo						
Perforaciones Delta CA (Caracas, Venezuela)	8	dsl	600	Emsco G-500	500	8,000
	11	dsl	130	Natl T-12	120	2,500
	13	dsl	1040	Emsco J-1250	1250	15,000
	14	dsl-elec	2000	Emsco ECB	1200	15,000
	15	dsl-elec	2000	Emsco ECB	1200	15,000
	16	dsl-elec	2000	Emsco ECB	1200	15,000
(Western)						
Perforaciones Delta CA (Caracas, Venezuela)	4	dsl	260	Ideco H-40-D	400	6,500
	9	dsl	1000	Emsco GB-800	900	12,000

The Petroleum Engineer's exclusive . . .

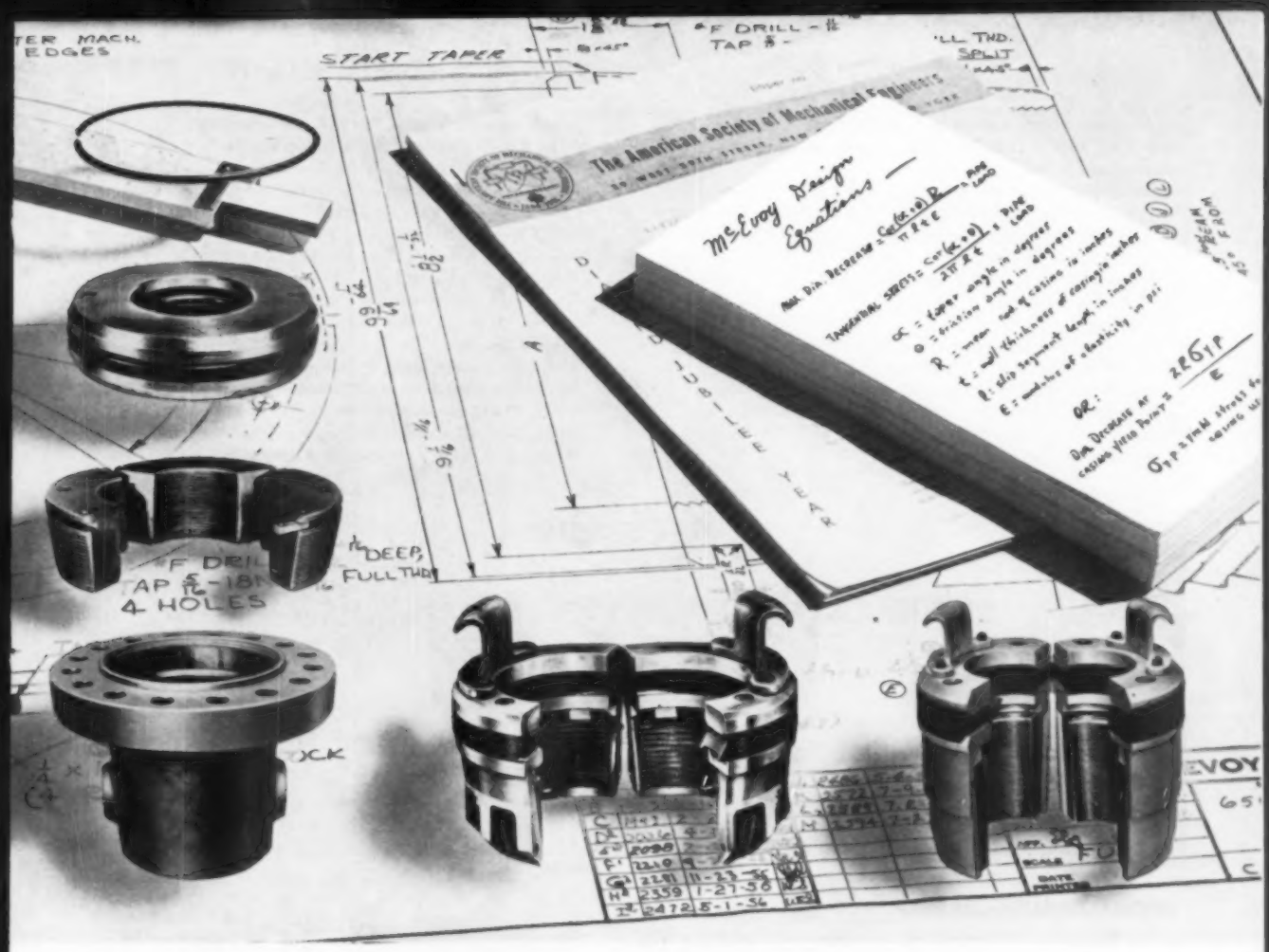
U.S. OFFSHORE RIG LOCATOR

The who, what, and where of U.S. offshore drilling — listing contractor, operator, location, water depth, type unit, and rig specifications

The U. S. offshore oil industry has had an uphill battle against the uncertain open water, fickle weather, and government bickering. In spite of these obstacles, activity and developments offshore have become significant and promise to provide much of the nation's future oil demand.

Drilling in the unprotected waters of the Gulf of Mexico and in the Pacific Ocean off the Coast of California is considerably more complicated than its comparable counterpart ashore. Although major items of drilling equipment have remained the same . . . drawworks, pumps, power compounds, derricks and masts, hoisting system, rotaries, etc., the supporting structure and allied machinery make the big difference. Drilling equipment is supported by minimum platforms with drilling tenders housing much of the needed facilities; on large self-contained platforms that have everything necessary for operation; on large mobile submersible barges, and on the West Coast, on ships.

Because the offshore drilling operation involves additional



How McEvoy uses "CONTROLLED FRICTION" to prevent casing failures

Engineered into each McEvoy Casing Hanger is the exclusive "Controlled Friction" principle, developed by McEvoy to permit hanging of casing to its full joint coupling strength without damage to the casing. This principle is your assurance of maximum safety and economy.

McEvoy "CF" Casing Hangers securely grip the casing with sharp inner teeth while precision-made outer teeth control the slip bowl friction, automatically limiting downward movement of slips in the bowl. These casing hangers effectively solve the problem of reconciling high load capacity and good initial pipe bite by increasing the friction between slip and bowl as the casing load increases, stopping downward casing travel *before* the casing is damaged by the slips.

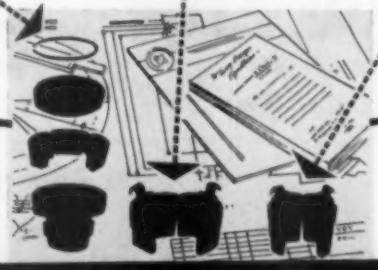
Hydraulic and mechanical loads are completely separated by use of two separate and independent support areas in these McEvoy Hangers. Pipe bottlenecking is completely eliminated and casing pressures, test pressures, or high pressure remedial work cannot load the slips or change their pipe load capacity.

McEvoy casing hangers for all wells

McEVOY "CB" CASING HANGER . . . designed for medium and medium-heavy casing strings . . . combines "Controlled Friction" slips and "Shielded Seal" pack-off with maximum economy . . . will safely hang casing to full short joint coupling strength.

McEVOY "CB-2" CASING HANGER . . . fits the space-saving, low-cost Type "C" Casing Head. Provides economical, medium duty, wrap-around, automatic set and seal service . . . may be wrapped around the pipe and dropped through the preventers to provide automatic sealing with very low pipe load and to safely support the pipe.

McEVOY SB-2 CASING HANGER . . . the complete answer to every deep, high pressure, heavy string need. May be wrapped around the pipe and dropped through the preventers for automatic set and seal . . . will safely support any casing string that can be picked up in the derrick.



McEvoy COMPANY

OIL WELL EQUIPMENT

Texas and Milby Street · P. O. Box 3127

Houston 1, Texas

● *For complete engineering design information on the exclusive McEvoy "Controlled Friction" principle, write for paper, "Effect On Thin-Walled Cylinders of Combined Loading From Tension and External Slip Compression."*

types of equipment and structures, the Editors of PE's exclusive RIG LOCATOR felt that it justified a separate and specialized listing.

Some abbreviations. To provide the greatest amount of information in a compact listing, it is necessary to employ some abbreviations. Manufacturer's names are indicated in the introduction of the RIG LOCATOR. Here is a list of abbreviations employed in the offshore section for operators and operator groups:

Operators

Std of Cal — Standard Oil Company of California.
Gen Pet — General Petroleum Corporation.
Humble — Humble Oil and Refining Company.
Std Texas — Standard Oil Company of Texas.
Std Cal — Standard Oil Company of California.
Texaco — The Texas Company.
Ark Fuel — Arkansas Fuel Oil Corporation.
Calif Co — The California Company.
Kermac — Kerr-McGee Oil Industries, Inc.
Pan Am — Pan American Petroleum Corporation.
Phillips — Phillips Petroleum Company.
CATC — Continental Oil Company, The Atlantic Refining Company, Tidewater Oil Company, and Cities Service Oil Company.
CUSS — Continental Oil Company, Union Oil Company of California, Shell Oil Company, and The Superior Oil Company.
Magnolia — Magnolia Petroleum Company.
M-C-N — Magnolia Petroleum Company, Continental Oil Company and Newmont Oil Company.
Richfield — Richfield Oil Corporation.
Superior — The Superior Oil Company.

CALIFORNIA

Owner's Name, Address	Rig, Barge Name or Number	Operator Drlg For	Offshore Location— (County)	Water Depth Ft	Type Rig Power	Drwwks Make & Model	Total hp Available to Drwwks	Total hp to all Main Mud Pumps	Rated Drlg Depth with 4½" Pipe
Brown Marine Drlg Co	Rig 1	Monterey	Seal Beach, Orange	45	dsl engine	Natl 50-A	750	750	8,000
Humble Oil & Ref Co	SM 1	Humble	Calif. Area	60–250	dsl engine	Hopper	300	175	3,500
Pacific Towboat & Salvage	"Torry"	Gen. Pet.	Santa Barbara	100	dsl engine	Wgnr Mrhse D15T4B	300	400	3,500
Richfield Oil Corp	"La Ciencia"	—	Goleta	200	dsl engine	Hopper Hoist	165	165	1,500
	"Rincon"	—	Pt. Concepcion	125	dsl engine	Emsco 160	400	300	4,000
Standard Oil Co of Calif	"Western Explorer"	—	Santa Barbara	200	dsl engine	Hopper Hoist	200	200	3,500

TEXAS

MOBILE DRILLING BARGES

Movible Offshore Co	Rig 2	Shell	Mustang Is. Area	—	dsl-elec	Natl 1625	2000	2000	20,000+

PLATFORM-TENDER DRILLING UNITS

Kerr-McGee Oil Ind Inc	Bge 16 "Kermac I"	Std of Tex	Mustang Is. Area St 948	50	dsl engine	Natl 100	900	900	12,500
	Rig 43 "Kermac II"	Humble	Mustang Is. Area St 819	55	dsl engine	Emsco J-1000	1350	1730	14,000
Magnolia Pet Co	Rig 61 "Gulf Coast Bge 2"	Magnolia	High Is. Area St 24	—	dsl-elec	Natl	1250	3500	16,000

SELF-CONTAINED PLATFORMS

C G Glasscock Drlg Co	Rig 1	Ark Fuel	Mustang Is. Area St 905 S	30	dsl engine	Natl 130	1200	1520	16,000

LOUISIANA

MOBILE DRILLING BARGES

Coral Drlg Co	"Mr. Arthur"	Calif Co	West Delta Area Blk 30	39	dsl-elec	Brwstr N-12	1250	2500	20,000
Delta Marine Drlg Co	Rig 2 "Chris Zeppa"	ODECO	W. Cameron Area Blk 3	20	dsl engine	Ideco Big Gnt	1600	1950	15,000
C G Glasscock Drlg Co	Rig 12 "Mr. Gus II"	CATC	Grand Is. Area Blk 48	77	dsl-elec	Natl 160-E	1950	3900	25,000
Humble Oil & Ref Co	Rig 47	Humble	Grand Is. Area Blk 18	45–60	dsl engine	Emsco GB 250-TS	260	500	5,000
Kerr-McGee Oil Ind Inc	Rig 40	Pure	Eugene Is. Area Blk 32	12	dsl engine	Emsco J-1600	1150	1250	16,000
	Rig 44	Kermac	Ship Shoal Area Blk 28	20	dsl engine	Ideco Hydrair 1350-S	1550	1760	20,000
	Rig 45	CATC	West Delta Area Blk 84	25	dsl engine	"Oilwell" 96-S	1150	1100	16,000
	Rig 46	CATC	Vermilion Area Blk 95	35	dsl-elec	Emsco EDA-460	1250	1250	20,000
	Rig 47	Shell	Ship Shoal Area Blk 139	47	dsl-elec	Emsco EDA-460	1250	1250	20,000

This *D-SANDER* has proved its value in these two important areas.

GULF COAST

The Dorrco D-Sander was originally developed to remove abrasive sands prevalent in Gulf Coast drilling down to about 9,000 feet. It has worked so well that it is rapidly becoming standard equipment on many Gulf Coast rigs.

On one series of controlled tests, for example, savings in overall drilling costs averaged more than $5,000 per well. Faster drilling rates, reduced pump repair costs and more footage per bit contributed to this saving.

MID-CONTINENT

In North Texas and Oklahoma, build-up of fine drilled solids were increasing viscosity and weight of the drilling fluid and reducing drilling rates.

SWACO Engineers set the D-Sander to remove all drilled solids above 30 microns in size and results were astounding. Drilling rates increased as much as 15 per cent. Bit footage increased as much as 25 per cent and mud control was greatly simplified. Important cost savings were realized.

Regardless of where you drill, the Dorrco D-Sander may save you money by maintaining a low solids, low weight, non-abrasive drilling fluid. For full information, call us.

SWACO

SALT WATER CONTROL Inc.

A Sid Richardson Development Company

1211 Ft. Worth National Bank Phone: ED 2-4434 Ft. Worth, Texas

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

LOUISIANA (Continued)

Owner's Name, Address	Rig, Barge Name or Number	Operator Drlg For	Location—Designation	Water Depth Ft.	Type Rig Power	Drwwks Make & Model	Total hp Available to Drwwks	Total hp to all Main Mud Pumps	Rated Drlg Depth with 4½" Pipe
Louisiana Delta Offshore Corp	"Delta No 1"	Shell	E. Cameron Area Blk 17	25	dsl-elec	Unit U-1220	1370	1400	20,000
Noble Drlg Co	— S-55	Calif Co	Bay Marchand Blk 2	14	dsl-elec	—	—	—	—
Ocean Drlg & Expl Co	"Mr. Charlie"	Shell	Vermilion Area Blk 111	—	dsl-elec	Emsco EDA	1500	1000	20,000
	"John Hayward"	ODECO	E Cameron Area Blk 4	—	dsl-elec	Emsco ECA	1200	1000	15,000
	"Margaret"	Shell	Eugene Is. Area Blk 128	—	dsl-elec	Emsco EDES	1500	1000	20,000
	"St. Louis"	Shell	South Pass Area Blk 24	—	dsl-elec	Emsco ECB	1200	1000	15,000
Penrod Drlg Co	Bge 51 "J M Woodruff"	Calif Co	Bay Marchand Blk 2	70	dsl-elec	Emsco EDES	1600	2450	20,000
Phillips Pet Co	Rig 42	Kermac-Phillips	Breton Sound Blk 22	10	dsl engine	"Oilwell" 76	825	650	12,000
Rowan Drlg Co Inc	Bge 19	Calif Co	Bay Marchand Blk 1	—	dsl-elec	Unit U-1220-E	2250	2100	20,000
Southeastern Drlg Corp	Rig 22 Bge 8	Calif Co	Bay Marchand	21	dsl engine	Natl	2200	1550	18,000
Zapata Off-Shore Co	Rig 2 "Scorpion"	Calif Co	S. Timbalier Area Blk 22	45	dsl engine	"Oilwell" 96	1850	1850	16,000
	Rig 3 "Vinegarroon"	Natural Oil & Gas	E. Cameron Area Blk 14	35	dsl engine	"Oilwell" 96	2080	2150	18,000

PLATFORM-TENDER DRILLING UNITS

Booker Drlg Co	Rig 3	Humble	West Delta Area Blk 30	45-60	—	—	—	—	—
Deepwater Expl Co	"Deepwater No. 1"	Humble	Grand Is Area Blk 28	45	dsl-elec	Natl 130-E	1200	2400	16,000
Delta Drlg Co	Rig 16	Humble	Grand Is. Area Blk 16	45-60	dsl engine	Beth MC-950	1400	1200	15,000
	Rig 35	Humble	West Delta Area Blk 30	45-60	dsl engine	Emsco J-1100	1200	1200	15,000
	Rig 37	Humble	West Delta Area Blk 30	45-60	dsl engine	Beth MC-950	1400	900	15,000
Delta Marine Drlg Co	Rig 1 "Joseph Zeppa"	M-C-N	W. Cameron Area Blk 110	42	dsl-elec	Emsco JB-1250	1600	1600	15,000
Dixilyn Drlg Corp	Rig 6 "Murmanill I"	Gulf	S. Timbalier Area Blk 21	40	dsl engine	Natl 130	1650	2475	17,500
Hawkins-Wilkins Prod Co	Rig 2	Humble	Eugene Is. Area Blk 77	45-60	dsl engine	Ideco PR-1050	900	1400	15,000
Humble Oil & Ref Co	Rig 36	Humble	West Delta Area Blk 30	45-60	dsl engine	Emsco J-1250	1000	1000	15,000
	Rig 46	Humble	Grand Is. Area Blk 18	45-60	dsl engine	Emsco J-1400	1000	1000	16,000
	Rig 49	Humble	Grand Is. Area Blk 17	45-60	dsl engine	Emsco J-1400	1000	1000	16,000
Kerr-McGee Oil Ind Inc	Rig 39 "Frank Phillips"	Humble & Gulf	West Delta Area Blk 24	30	dsl engine	Natl 125	1800	1200	16,000
	Rig 48 "Kermac III"	CATC	Vermilon Area Blk 120	65	dsl-elec	Emsco EDA-460	2625	2625	16,000
Llano Drlg Co	Rig 6 "Clayton G Dorn"	Forest	Ship Shoal Area Blk 149	55	dsl engine	"Oilwell" 96	1800	2475	20,000
Loffland Bros	Rig 127 "R W McIlvain"	Pure Group	E. Cameron Area Blk 126	72	dsl engine	Natl 125	1560	1560	15,000
	Rig 30 S-26	Calif Co	Bay Marchand Ar.	43	dsl engine	Unit U-30	1200	1800	15,500
	Rig 1 & Rig 148 S-24	Calif Co	West Delta Area Blk 29	39	dsl engine	Natl 125	1500	1850	18,000
	Rig 133	Calif Co	Main Pass Area Blk 60	62	dsl engine	Unit U-30	1200	1800	15,500
	Rig 149	CATC	S. Timbalier Area Blk 22-5/2	40	dsl engine	Unit U-1220	1500	1500	20,000
Magnolia-Continental-Newmont	Rig 34 Bge 1	M-C-N	Ship Shoal Area Blk 42	20	dsl engine	Natl 125	1040	1040	15,000
	Rig 39 Bge 2	M-C-N	Eugene Is. Area Blk 128	45	dsl engine	Natl 125	1240	1300	15,000
	Rig 44 Bge 5	M-C-N	Eugene Is. Area Blk 110	30	dsl engine	Emsco JB-1250	1040	1040	15,000
	Rig 45 Bge 6	M-C-N	Eugene Is. Area Blk 126	40	dsl engine	Natl 125	1040	1080	15,000
	Rig 47 Bge 3	M-C-N	Ship Shoal Area Blk 113	40	dsl engine	Natl 125	1040	1040	15,000
	Rig 48 Bge 4	M-C-N	E. Cameron Area Blk 64	45	dsl engine	Emsco JB-1250	1040	1040	16,000
	Rig 57 Bge 7	M-C-N	S. Pelto Area Blk 11	40	dsl engine	Natl 130	1040	1040	16,000

LOUISIANA (Continued)

Owner's Name, Address	Rig, Barge Name or Number	Operator Drlg For	Location—Designation	Water Depth Ft.	Type Rig Power	Drwwks Make & Model	Total hp Available to Drwwks	Total hp to all Main Mud Pumps	Rated Drlg Depth with 4½" Pipe
Noble Drlg Co	— S-21	Calif Co	West Delta Area Blk 29	39	dsl-elec	—	—	—	—
	— S-22	Calif Co	Bay Marchand Area	36	dsl-elec	—	—	—	—
	— S-23	Calif Co	Bay Marchand Area	18	dsl-elec	—	—	—	—
	— S-24	Calif Co	S. Timbalier Area Blk 63	96	dsl-elec	—	—	—	—
Penrod Drlg Co	Rig 10 "Eagle"	Gulf	S. Timbalier Area Blk 135	186	dsl engine	Natl 130	1500	1520	18,000
Phillips Pet Co	Rig 40	Phillips	Bay Marchand Blk 5	35	dsl engine	Natl 125	1350	1200	16,000
Reading & Bates Offshore Drlg Co	"J W Bates"	CATC	E. Cameron Area Blk 71	60	dsl engine	Natl 130	2000	3000	20,000+
	"Geo M Reading"	CATC	Vermilion Area Blk 102	60	dsl engine	Natl 130	2000	3000	20,000+
Rowan Drlg Co Inc	Rig 17	CATC	E. Cameron Area Blk 63	—	dsl engine	Natl 125	1305	2100	15,000
	Rig 30	Humble	Grand Is. Area Blk 18	—	dsl engine	Emsco A-1500	2400	2000	18,000
Southeastern Drlg Corp	Rig 12 Bge 9	Union of Calif	Vermilion Area Blk 67	—	dsl engine	"Oilwell" 96	1100	2250	16,000
Zapata Off-Shore Co	Rig 1 "Nola"	Magnolia	Eugene Is. Area Blk 89	30	dsl engine	Natl 130	1400	1850	15,000

INLAND BARGE — PLATFORM

Magnolia Pet Co	Rig 52 "Gulf Coast Bge 1"	Magnolia	Main Pass Area Blk 46	24	dsl engine	Natl 125	1560	1560	15,000

SELF-CONTAINED PLATFORMS

Big Chief Drlg Co	Rig 34	Phillips	Eugene Is. Area Blk 172	85	dsl-elec	Emsco EDA-460	1600	2560	18,000
Brewster-Bartle Drlg Co	Rig 1-A	CATC	West Delta Area Blk 45	—	dsl engine	"Oilwell" 96	3300	3300	20,000
Dixilyn Drlg Co	Rig 7	Gulf	Ship Shoal Area Blk 154	56	dsl engine	Natl 110	2475	2475	15,000
Humble Oil & Ref Co	Rig 50	Humble	Grand Is. Area Blk 16	45–60	dsl engine	Unit U-40	900	450	10,000
Loffland Bros	Rig 46	CATC	Grand Is. Area Blk 47	96	dsl-elec	Natl 34-10	2840	1550	20,000
	Rig 62	CATC	Grand Is. Area Blk 47	95	dsl-elec	Natl 34-10	1500	1600	20,000
	Rig 125	Phillips	Eugene Is. Area Blk 129-A	52	dsl-elec	Natl 34-10	1600	1050	20,000
	Rig 144	Shell	Eugene Is. Area Blk 128-A	48	dsl engine	Unit U-30	1500	1500	18,000
Phillips Pet Co	Rig 45	Phillips	Eugene Is. Area Blk 191	85	dsl-elec	Emsco ECC	1250	1250	18,000
The Power Rig Drlg Co	Platform 9	Magnolia	S. Pelto Area Blk 87	30	dsl engine	Unit U-15	750	1000	11,000
Rimrock-Tidelands Inc	"Rimrock I"	Sinclair	Eugene Is. Area Blk 175-A	87	dsl engine	Beth MC-950	1200	1200	16,000
	"Rimrock III"	Sinclair	S. Timbalier Area Blk 86	87	dsl-elec	Brwstr N-12A	1400	1800	18,000
	"Rimrock 14"	Sinclair	Eugene Is. Area Blk 175-B	87	dsl engine	Emsco A-1500	2000	2000	18,000
	"Rimrock 15"	Sinclair	Eugene Is. Area Blk 190-A	75	dsl engine	Brwstr N-12A	2000	2000	18,000
Rowan Drlg Co Inc	Rig 8	Humble	Grand Is. Area Blk 18	—	dsl engine	Natl 125	2340	1920	18,000
	Rig 11	CATC	Grand Is. Area Blk 40	—	dsl engine	Unit U-1220	2400	2250	20,000
Shoreline Drlg Co Inc	Rig 3	CATC	West Delta Area Blk 58	—	dsl engine	Unit U-1220	2400	2400	20,000
	Rig 7	CATC	West Delta Area Blk 59	—	dsl engine	Unit U-1220	2400	2400	20,000
Southeastern Drlg Corp	Rig 7	M-C-N	Eugene Is. Area Blk 128	52	dsl engine	"Oilwell" 96	1560	1040	14,000
	Rig 25	M-C-N	Eugene Is. Area Blk 128	52	dsl engine	Natl 130	1560	1040	16,000
Superior Oil Co of Calif	Rig 27	Superior	W. Cameron Area Blk 72	48	dsl engine	Natl 125	900	900	12,500
	Rig 20	Superior	W. Cameron Area Blk 101	48	dsl engine	Natl 125	900	900	12,500

Energy (physics) means "Capacity for performing work."

And that, in a nutshell, is J&L wire rope.

There IS a difference. You can pick up a good wire line anywhere, but J&L wire rope (independent wire rope center, fiber core, SpringKore, PlastiKore) is nothing short of coiled POWER! It tackles tough jobs with amazing endurance. Precision engineered, it handles with easy assurance. Its plus values pay bigger dividends than blue chip stocks.

Try it! Make up your mind now to standardize on J&L wire rope for the pure satisfaction of owning a finer product.

FREE BOOKLET

Call any J&L number for your copy of WIRE ROPE IS A MACHINE, packed with practical information on selecting, handling, maintenance.

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SUPPLY DIVISION – Tulsa

SERVING THE UNITED STATES AND CANADA

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Schulz and Schultz know for sure . . .

Why Cost-Conscious Mud Engineers Specify Du Pont CMC

Warren Schulz (left), manager of the New Orleans office of Barada & Page, shows Eddie Schultz, Du Pont Technical Representative, newly replenished stock of the multi-purpose mud additive, Du Pont CMC. Rapidly increasing sales volume is his proof that Du Pont CMC is being specified by more and more mud engineers. To give prompt delivery throughout his area, this office now stocks Du Pont CMC in Baton Rouge, Lake Charles and Mobile, in addition to New Orleans.

And Eddie Schultz (right) can tell you why. He's a mud engineer himself, has trained mud engineers and drilling personnel, and has helped evaluate all types of drilling mud additives. Now, as a Field Representative for Du Pont, he's helped oil producers save substantially per foot in mud costs by using Du Pont CMC. He can show you why it is the best additive on the market to give fluid-loss control at low viscosity *and* at low cost.

If you don't know Schulz or Schultz, why not get acquainted and take advantage of their services and the benefits of Du Pont CMC? Order it from:

- YOUR LOCAL MUD DEALER
- BARADA & PAGE—Corpus Christi, Dallas, Ft. Worth, Houston, New Orleans, Odessa, Oklahoma City, Kansas City, Tulsa, Wichita.
- MACCO CORP., Paramount, Calif.
- DU PONT EXPLOSIVES DEPARTMENT offices in Dallas, Los Angeles, or Wilmington, Del.

DU PONT
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Better Things for Better Living
... through Chemistry

DU PONT CMC FOR DRILLING MUDS

MISSION Super-Service® LINER PACKING

MISSION Super-Service Slush Pump Liner Packing outwears all other types.

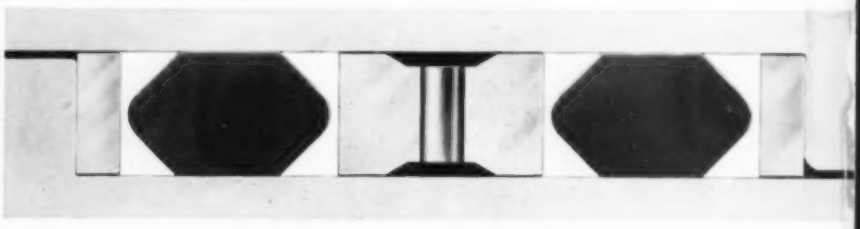
Under severe conditions (high pressures and worn pump bores) Mission Packing has outlasted others by as much as ten times.

Furthermore, Mission Super-Service Packing stays in adjustment. Since costly wear is reduced, frequent re-tightening is seldom required.

The reason for this outstanding performance is the *zero* clearance design shown below.

Write for the bulletin that tells the whole story. Better yet, try Mission Super-Service Liner Packing in your pumps. They are made in many popular sizes and are sold through all supply stores.

This cross-section shows how nylon back-up rings expand to provide zero clearance and perfect containment of packing elements when tightened. The metal end ring restores worn shoulders—adding reinforcement to the nylon. The result is long life with minimum adjustment.



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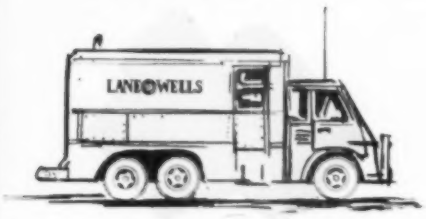
Complete Perforating Service

bullet or shaped-charge

LANE-WELLS GETS DEEPER PENETRATION

Yes, when you use Lane-Wells perforating service you can get maximum penetration in both bullet and shaped-charge perforating...

...BECAUSE



Because Lane-Wells 4 inch E-Gun blasts deeper than any 4 inch bullet gun available on the market today—25% deeper than its closest competitor.*

...BECAUSE

Because Lane-Wells 4 inch Karrotfree Koneshot ® blasts deeper than any 4 inch shaped-charge gun available on the market today—shoots 12.3% deeper than its closest competitor.*

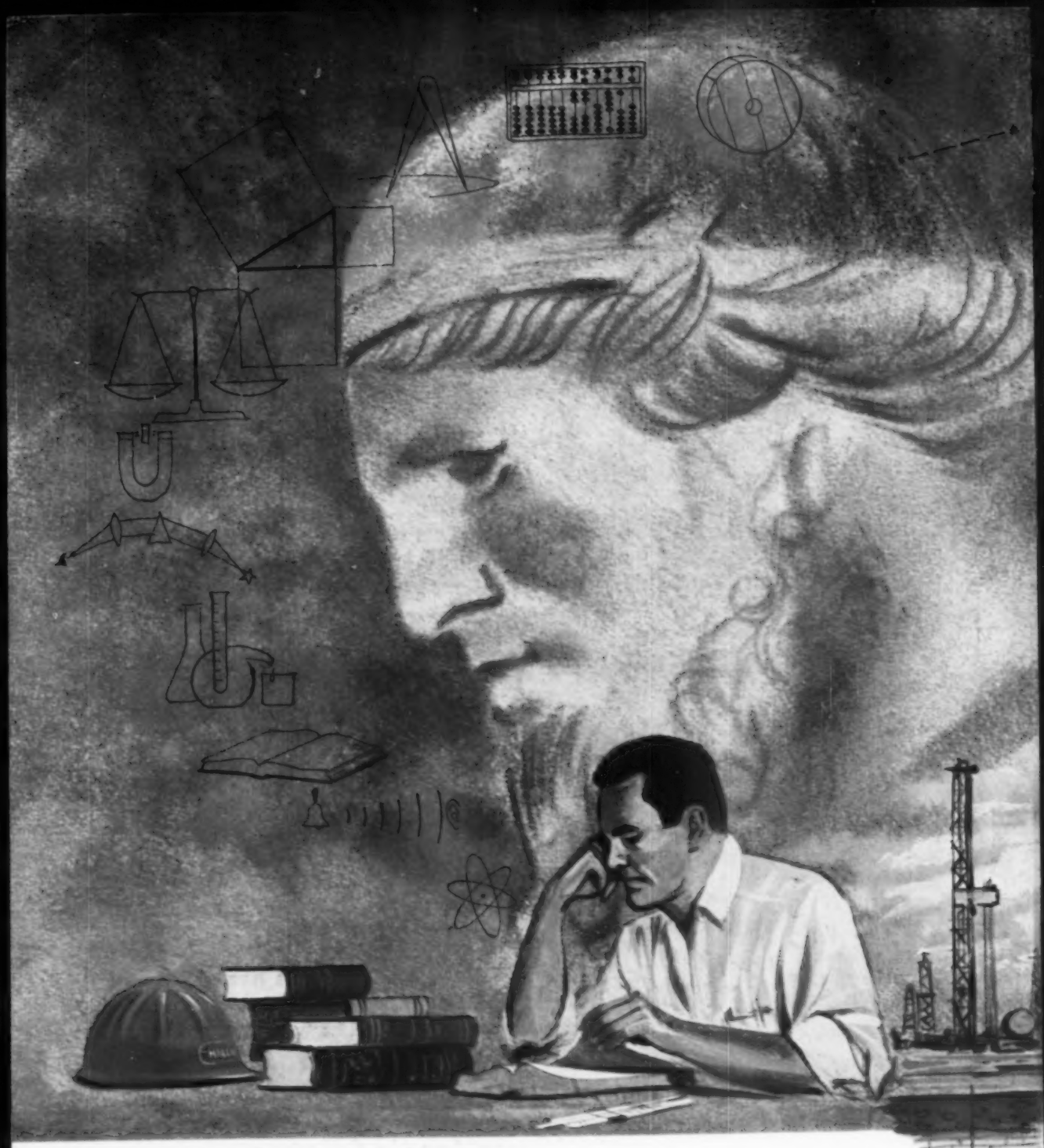
* From the published results of independently conducted tests.

Your LANE WELLS man has the full story ...ask him to give you the facts

LANE-WELLS COMPANY

FOR INFORMATION WRITE:
P. O. BOX 1664, HOUSTON 1, TEXAS

LANE-WELLS CANADIAN CO. IN CANADA
PETRO-TECH SERVICE C.A. IN VENEZUELA



knowledge

Ever since the dawn of civilization, trails of progress have been blazed by men of knowledge. The path of petroleum is no exception. Built by the step-by-step accumulation of knowledge, the path of oil leads from deep in the earth's crust to the world above, providing energy for the needs of mankind.

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